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LITHOLOGIC DESCRIPTION OF CORED WELLS #20402
AND #20403 IN THE DEVONIAN SHALE IN LINCOLN
COUNTY, WEST VIRGINIA

by

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Lithologic Description of Cored Wells #20402
and #20403 in the Devonian Shale in
Lincoln County, West Virginia

Cored Well #20402
Cored Intervals: 2654'-2770'
3000'-3118'
3290'-3588'
3886'-3968'

and

Cored Well 20403
Cored Interval: 2720'-4028'

by

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Lithologic Description of the Devonian Shale in Lincoln County, West Virginia

INTRODUCTION

This report presents a detailed lithologic description of the Upper Devonian Shale as observed in cores taken from two wells near Ranger, Lincoln County, West Virginia. One of the cored wells, #20402 (West Virginia Permit No. 1636), is located approximately three miles southwest of Ranger, West Virginia on Ten Mile Creek (Figure 1) while the second cored well #20403. (West Virginia Permit No. 1637), is located near the first well, but is located on Fourteen Mile Creek (Figure 1).

PURPOSE

The wells were cored to characterize in detail the Devonian Shale in the southwestern portion of West Virginia. More specifically, analysis of the core material is providing information to be used in designing stimulation techniques for the improvement of gas production from the Devonian Shale. The cores were obtained in support of a cooperative project between ERDA and Columbia Gas Transmission Corporation to test the feasibility of inducing massive hydraulic fractures in the shale as a means of stimulating the production of gas. Attempts are being made in the cored wells to create fractures several hundred feet high and 1,000 to 2,000 feet long in the hope of encountering a large number of natural fractures in the shale which will greatly improve gas production.

Specifically, the core data will be used to locate and characterize those zones of brown shale with high hydrocarbon content. The lithologic information will then be used to stratigraphically correlate these zones with other areas of the Appalachian Basin. The well will be deviated to an inclination of 60° and then be stimulated by multiple stage hydraulic fracturing in an effort to increase the rate of recovery of gas from the shale and the total amount of reserves assigned to a single well.

This cost sharing experiment is designed to test and evaluate the technical and economic potential of massive hydraulic fracturing for increasing gas recovery from the Devonian Shales of West Virginia and is the first of a series of tests which will be conducted over the next few years in accordance with established plans of ERDA's Eastern Gas Shales project.

GENERAL GEOLOGY

The general surface geology of the area contains rocks of Permian Age (Figure 2). The lowest members of the Dunkard Group cap the highest hills in the area. The Mannington Sandstone is the first unit to be represented followed by the Waynesburg Sandstone, which outcrops in bold cliffs.

The Monongahela Group is the highest group of the Pennsylvanian System. Some prominent units within the Monongahela Group are the Waynesburg Coal,

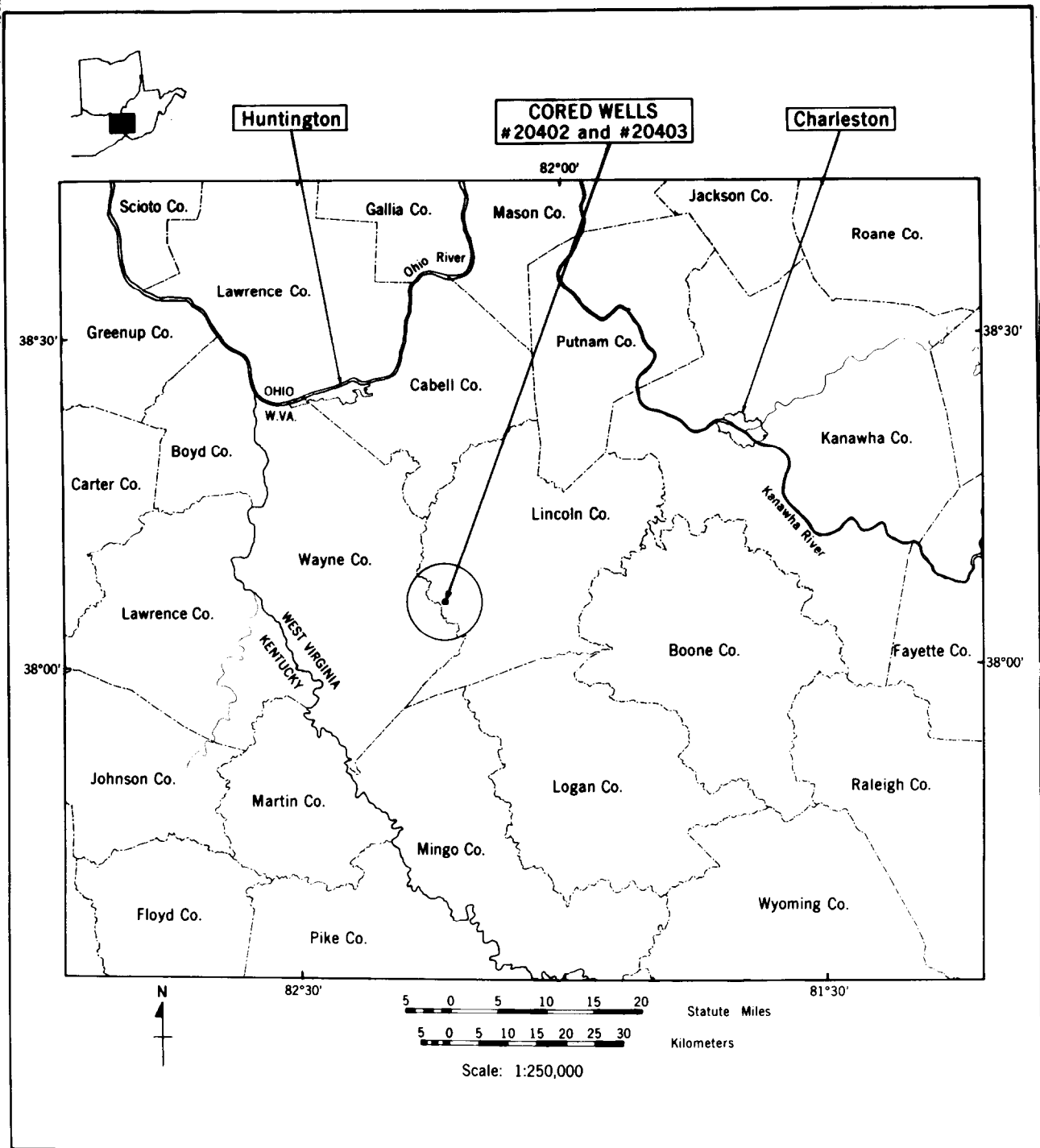


Figure 1 - Location of Cored Wells

GENERALIZED GEOLOGIC COLUMN				
SYSTEM	GROUP OR FORMATION	IMPORTANT ROCK UNITS	ROCK COLUMN	DRILLERS TERMS
PERMIAN	DUNKARD	Surface		
		Lower Marietta SS Waynesburg SS		Washington Coal
PENNSYLVANIAN	MONONGAHELA	Waynesburg Coal Uniontown Coal Pittsburgh Coal Connellsville SS		Gilboy Sand Arnoldsburg Sand Pomeroy Sand
		Bakerstown Coal Mahoning SS		Morgantown Sand Saltsburg Sand
	ALLEGHENY	Lower Freeport Coal Freeport SS Lower Kittanning Coal		Coal Blossom No. 5 Block
	POTTSVILLE	Homewood SS Nuttall SS No. 2 Gas Coal		Roaring Creek Sand Salt Sands
MISSISSIPPIAN	MAUCH CHUNK	Princeton SS Maxton SS		Ravencliff Sand Lower Maxton
	GREENBRIER	Greenbrier Limestone		Blue Monday Big Lime
		Big Injun SS		Keener Sand
	POCONO	Squaw SS Weir Sand Berea SS		Sunbury Shale
DEVONIAN	HAMPSHIRE CHEMUNG	Fifty-foot SS Gordon SS Fifth Sand		
		Speechley Sand		
	MILLBORO (MARCELLUS) SHALE	Balltown Sand Benson Sand		BROWN SHALE
		Onondaga LS		Chert (Corniferous) Oriskany Sand
	HELDERBERG	Helderberg LS		

Figure 2 - Surface Geology of Area

Lilboyst Sandstone, Redstone Coal, and the Pittsburgh Coal. The Pittsburgh Coal, the lowest unit of this group, is also valuable economically.

The Conemaugh Group contains the Connellsville, Morgantown, and Mahoning Sandstones. The Bakerstown Coal is also found in this group but it is of no commercial value.

The Allegheny Formation contains the Upper and Lower Freeport Coals, the Freeport Sandstone, and the Lower Kittanning Coal (No. 5 Block). The No. 5 Block Coal is the most persistently occurring coal seam of the formation in this area and the most valuable.

The lowest group of the Pennsylvanian System is the Pottsville. The Homewood Sandstone, the Salt Sands (1st, 2nd, and 3rd), and the No. 2 Gas Coal are prominent units in the Pottsville Group.

The Mississippian System begins with the Mauch Chunk Group of which the most prominent unit is the Maxton Sandstone. The Greenbrier Group is middle Mississippian and contains the Big Lime of West Virginia and the Keener Sandstone. The lowest group of the Mississippian is the Pocono. Important units in this group are the Big Injun, Squaw, Weir, and Berea Sandstones.

The Hampshire Formation is at the top of the Devonian System. Prominent units in this formation are the Fifty-Foot, Gordon, and Fifth Sandstones. The Millboro Group (Marcellus) is middle Devonian and contains the Speechley, Balltown, and Benson Sandstones. The study unit is the Brown Shale of West Virginia. It is found in the Upper and Middle Devonian. The lower Devonian or Helderberg Group contains the Onondaga Limestone, Oriskany Sandstone, and the Helderberg Limestone.

SUMMARY

The core sections being studied are Devonian Brown Shale from two wells in the Laurel Hill District of Lincoln County, West Virginia. The two cored wells are 600 yards apart and are near the Wayne-Lincoln county boundary (Figure 1). The total thickness of the Devonian Shale in this area is nearly 1400 feet.

The first well, #20403 (West Virginia Permit No. 1637), was cored in January 1976 and contains the entire Devonian Brown Shale sequence from the bottom of the Berea Sandstone to the top of the Onondaga Limestone (Figure 3). The top of the cored section is at 2720 ft. and the bottom at 4028 ft. The total amount of core taken was 1308 ft.

Analysis of this core section (Appendix A) shows most of the core to be medium grey (N-5) and greenish grey (5GY 6/1) to dark grey (N-3) and dark greenish grey (5GY 4/1). The zones from 3175-3200 ft., 3275-3425 ft., 3500-3650 ft., and 3980-4025 ft. are predominately greyish black (N-2) and brownish black (5YR 2/1).

Microcrystalline pyritic material, micaceous (muscovite) minerals, spore casts, and spore replacements are abundant throughout the core interval.

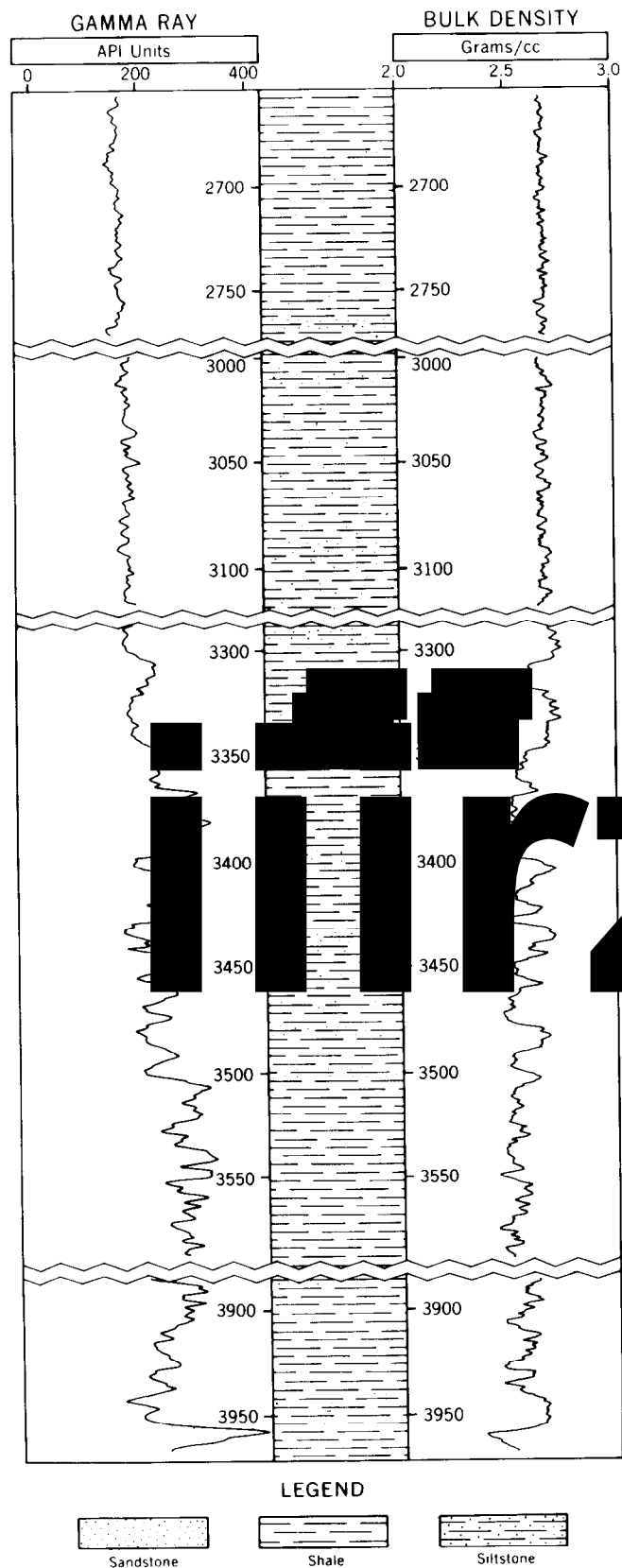


Figure 3 - Logs of Core Well #20402

Carbonaceous plant fragments and pelecypods are found mainly in the darker zones. A smell of gas is present on freshly broken surfaces in the darker zones.

Vertical fractures are most abundant in the zone from 3050-3750 ft. with a dominant fracture trend striking northeast. The shear fractures are found consistently throughout the interval with a dominant trend striking northeast also.

The second well #20402 (West Virginia Permit No. 1636), was cored in March 1976. Six hundred-fourteen feet of core were taken in four different zones through the Devonian Shale (Figure 4). The cored intervals were 2654-2770 ft., 3000-3118 ft., 3290-3588 ft., and 3886-3968 ft.

Most of the first sone (Appendix B) is dark grey (N-3) to greyish black (N-2) with some greenish grey (5GY 6/1) zones also. Cross-bedding, loading features, micaceous (muscovite) minerals, and carbonaceous plant fragments are found in this section.

This interval contains a few vertical fractures, which strike northeast. The shear fractures are more abundant and are striking northeast also.

The second zone (3000-3118 ft.) is predominantly dark grey (N-3) to greyish black (N-2). There are pyritized spore casts, micaceous minerals, cross-bedding, and some carbonaceous fragments found throughout.

Vertical fractures are concentrated between 3060-3070 ft. and 3090-3115 ft. with a few fractures scattered through the rest of the section. The shear fractures were abundant throughout the interval. Both the vertical and shear fractures consistently strike northeast.

The third zone (3290-3588 ft.) is mostly greyish black (N-2) to dark grey (N-3) with two black (N-1) zones. This section contains pyritic nodules and stringers, pyritized worm burrows, micaceous (muscovite) minerals, and a few carbonaceous plant fragments. Cross-bedding and loading features are present in the silty zones.

Vertical and shear fractures are found throughout the interval, with a dominant fracture trend striking northeast. Some of the vertical fractures would extend continuously for four or five feet.

The fourth zone (3886-3968 ft.) is greyish black (N-2) with silty shale zones of light olive grey (5Y 6/1) to olive grey (5Y 4/1). This interval contains pyritic nodules and stringers, pyritized worm burrows, micaceous (muscovite) minerals, and loading features. Slickensides (45° dip), shear fractures and mineral filled fractures are also evident.

Vertical fractures are not abundant and they are found in the zone from 3885 to 3900 ft. The shear fractures are found throughout the interval. Both the vertical and shear fractures have major trends striking northeast.

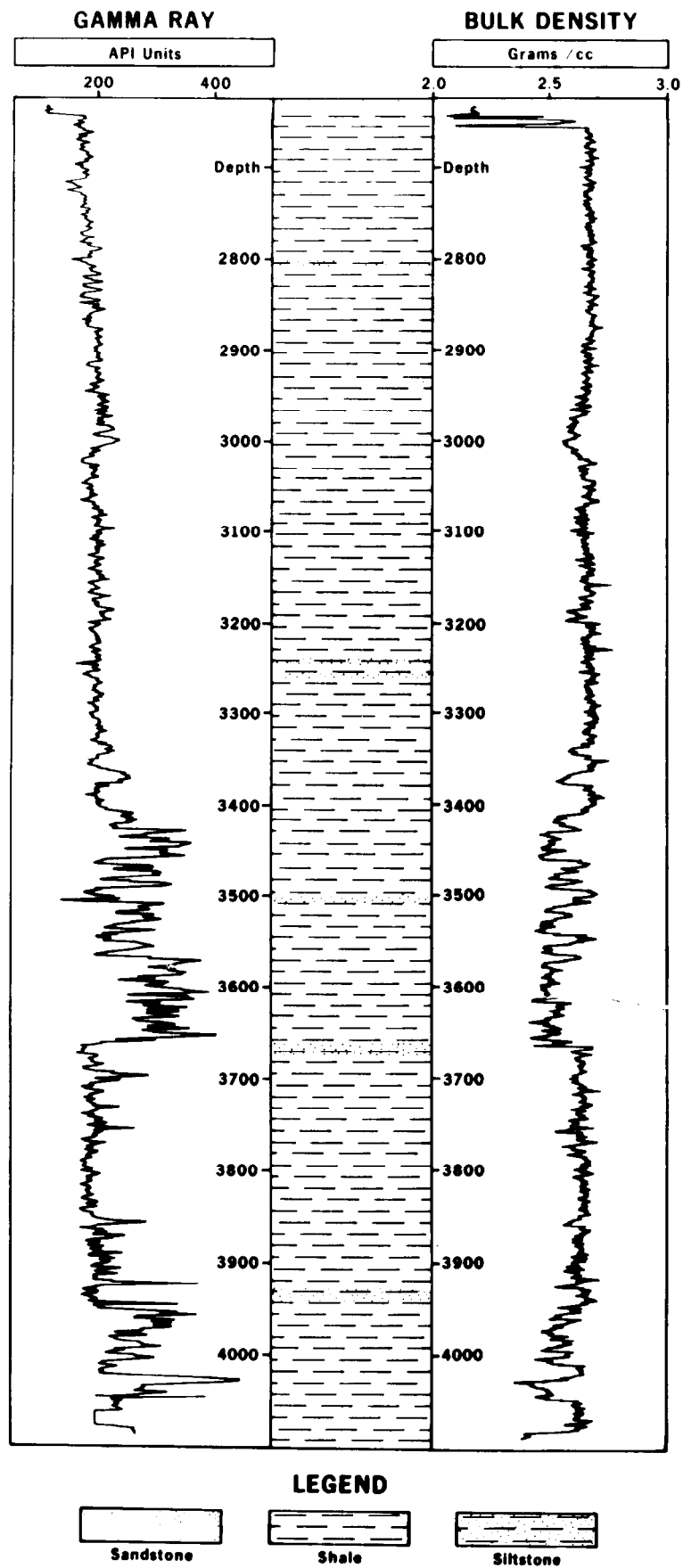


Figure 4 - Logs of Core Well #20403

APPENDIX A

LINCOLN COUNTY, W. VA. #20403

Top	Bottom	Thickness (ft.)	Lithologic Description
2720'	2727'4"	7'4"	Siltstone, greenish grey, 5GY 6/1 and shale, N-4 medium dark grey. A large zone (10") of siltstone at 2723'. Silty stringers (2-4") and thin laminations of N-4 shale are evident along with N-5 laminations and silty (N-6) lenses. Cross-bedding is present and some loading features are found in core section. Siltstone (5GY 6/1), 65%; shale; N-4, 20%; N-5 (medium grey), 15%.
2727'4"	2733'8"	6'4"	Siltstone and shale, 5GY 6/1 greenish grey (siltstone) and 5 GY 4/1 dark greenish grey (shale stringers) are thinly laminated. Loading features and non-calcareous silty cross-bedding throughout. 5GY 6/1, 75% and 5 GY 4/1, 25%.
2733'8"	2741'9"	8'1"	Siltstone, 5 GY 6/1, greenish grey, thinly laminated with 5 GY 4/1 (silty shale). Much loading and cross-bedding. Non-calcareous. 5 GY 6/1 65%. 5 GY 4/1, 35%.
2741'9"	2748'3"	6'6"	Siltstone, 5 GY 6/1, greenish grey, with silty shale stringers (N-4) medium dark grey and non-calcareous. Small specs of mineralized material on surface of vertical fracture at 2742' and 2745'. 5 GY 6/1, 55% and N-4, 45%.
2748'3"	2756'4"	8'1"	Siltstone, greenish grey 5 GY 6/1, and light greenish grey, 5 GY 4/1. Silt and shale are intermittently laminated into thin stringers. Shale is in medium grey N-5 and medium dark grey N-4. Cross-bedding is evident. Non-calcareous. Silt = 60% 5 GY 6/1, shale 40% (N-5 25%, N-4= 15%.)
2756'4"	2762'4"	6'	Siltstone, greenish grey 5 GY 6/1 non-calcareous. Thin laminations of N-3, dark grey shale and N-4 medium dark grey shale are evident between the 1"-2" silty stringers. Loading features in contacts between silt and N-4 shale. Cross-bedding is evident in some silty zones. Siltstone 50%, 5 GY 6/1 shale = 50% (N-4 30% N-3 20%.)

LINCOLN COUNTY, W. VA. #20403

Top	Bottom	Thickness (ft.)	Lithologic Description
2762'4"	2768'9"	6'5"	Siltstone, yellowish grey 5 Y 8/1, shale N-3, dark grey and N-4, medium dark grey. Thinly laminated beds. Cross-bedding is evident throughout. Siltstone = 55% 5 Y 8/1, Shale = 45% (N-4 = 25% N-5 = 20%).
2768'9"	2776'6"	7'9"	Siltstone, N-7, light grey and shale N-3 dark grey, N-4 medium dark grey, and N-5 medium grey. Loading features and cross-bedding very apparent. Siltstone = 60% N-7, Shale = 40% (N-4 → 10% N-3 → 10% and N-5 20%). Slightly calcareous.
2776'8"	2779'3"	2'7"	Siltstone 5 GY 6/1 greenish grey with shale stringers N-4 medium dark grey. Loading and cross-bedding throughout. Non-calcareous. 55%, 5 GY 6/1 45%, N-4.
2778	2784'11"	6'11"	Silty shale N-4 medium dark grey with intermi-tent stringers of siltstone 5 GY 6/1 greenish grey and 5 GY 8/1 light greenish grey. (Slightly calcareous) @ 2783'8" a 4" section of 5 YR 4/1 brownish grey shale 40% N-4, 35% 5 GY 6/1, 20% 5 GY 8/1, 5% 5 YR 4/1.
2784'11"	2792'6"	7'7"	Shale N-3 dark grey laminated with silty stringers 5 GY 6/1 greenish grey varying from 1/8" to 2". Cross-bedding in siltstones non calcareous 55% N-3, 45% 5 GY 6/1.
2792'6"	2799'4"	6'10"	Siltstone 5 GY 8/1 light greenish grey and 5 GY 6/1 greenish grey with silty shale stringers N-4 medium dark grey. 5 GY 8/1 siltstone slight calcareous. Loading and cross-bedding evident 30% N-4, 45% 5 GY 6/1, 25% 5 GY 8/1.
2799'4"	2806'9"	7'5"	Shale 5 GY 4/1 dark greenish grey laminated with silty shale stringers 5 GY 6/1 greenish grey 1/16" to 2". Loading features cross-bedding in stringers also slightly calcareous 60% 5 GY 4/1, 40% 5 GY 6/1.

LINCOLN COUNTY, W. VA. #20403

Top	Bottom	Thickness (ft.)	Lithologic Description
2806'9"	2813'2"	6'5"	Siltstone, N-7, light grey and shale N-3, dark grey, N-4, medium dark grey. Stringers of non-calcareous silt are evident with thin laminations of N-3, 4 shale found intermittently in the section. Loading effects are evident along with some cross-bedding. Siltstone 45% shale 55% (N-3 = 10% N-4 = 25% and N-5 = 20%).
2813'2"	2819'8"	6'6"	Siltstone, 5 Y 6/1, light olive grey, and shale, N-4 medium dark grey and N-5 medium grey, with some dark thin layers. Silt and shale are intermittently found in thin laminations. Most of the section is non-calcareous. Cross-bedding is evident. Siltstone = 40% shale 60% = (N-3 10% N-4 = 25%, N-5 20%).
2819'8"	2827'	7'4"	Shale, N-4 medium dark grey, and N-5 medium grey siltstone, N-7, light grey. Some cross-bedding. Non-calcareous. Thinly laminated stringers of shale and silt. Shale (N-3) 12" zone ~2820'. Shale = 60% siltstone 40% (N-3 20% N-4 and N-5 20%).
2827'	2833'	6'	Shale, N-3 (dark grey) N-4 (medium dark grey and N-5 (medium grey). Siltstone, N-7 (light grey) non-calcareous. Thin 1" stringers with a 4" zone ~ 2877'. Some cross-bedding. Shale = 55% N-3 = 15%, N-4 = 25%, N-5 25%) siltstone = 45%.
2833'	2836'6"	3'6"	Shale, 5 GY 4/1, dark greenish grey laminated with siltstone 5 GY 6/1 greenish grey. non-calcareous, cross-bedding evident. 65% 5 GY 4/1, 35% 5 GY 6/1.
2836'6"	2842'2"	5'8"	Shale, 5 GY 4/1 dark greenish grey with 5 GY 6/1 silty shale stringers 10" section @ 2841' of 5 YR 2/1 brownish black shale. Siltstone stringers 5 GY 8/1 (calcareous) cross-bedding 50% 5 GY 4/1, 20% 5 GY 6/1, 20% 5 GY 8/1, 10% 5 YR 2/1.

LINCOLN COUNTY, W. VA. #20403

Top	Bottom	Thickness (ft.)	Lithologic Description
2842'2"	2848'8"	6'6"	Shale, 5 GY 4/1, dark greenish grey to N-3 dark grey with silty stringers 5 GY 6/1 greenish grey (slightly calcareous) Loading features @ 2844' and 45' Some pyrite filled spores. 40% 5 GY 4/1, 30% N-3, + 30% 5 GY 6/1.
2848'8"	2856'8"	8'	Shale, 5 GY 4/1 dark greenish grey to 5 Y 2/1 olive black with silty stringers 5 GY 6/1 greenish grey. Large carbonaceous fragment @ 2851' in 5 Y 2/1 zone. Cross-bedding and loading in silt. 35% 5 GY 4/1, 35% 5 GY 6/1, + 30% 5 Y 2/1.
2856'8"	2863	6'4"	Shale, 5 GY 4/1 dark greenish grey to 5 Y 2/1 olive black, with silty shale stringer 5 GY 6/1 greenish grey (non-calcareous) pyritized cluster of spores at 2856'10". 60% 5 GY 4/1, 20% 5 Y 2/1, 20% 5 GY 6/1.
2863'	2870'	7'	Shale, medium dark grey N-4 and medium grey N-5. Some thin laminations of N-3 dark grey shale. Most of core section is thinly laminated shades of shale and thin silty stringers (N-6 medium light grey and N-7 light grey). Some pyrite zones are evident and loading effects. Shale = N-5 40% (N-4 25%, N-3 15%) Siltstone = 20% (N-6 10%, N-7 10%).
2870'	2878'	8'	Shale, medium dark grey N-4 and N-5 medium grey. Thin laminations of N-4 and N-5 are found throughout this section. Some thin layers of N-3 dark grey are found ~ 2877.0'. Silty stringers are found intermittently non-calcareous. Shale 95%: Silt 5% n-3 → 15% N-4 → 35%, N-5 45%.
2878'	2884'	6'	Shale, medium dark grey N-4, and silty zones (N-7, light grey). The silty stringers are calcareous and have thin laminations of shale. Some loading features are evident. Shale = 90% (N-3 → 15%, N-4 → 30%, N-5 → 45%) Silt: 10%.

LINCOLN COUNTY, W. VA. #20403

Top	Bottom	Thickness (ft.)	Lithologic Description
2884'	3891'9"	7'9"	Shale, medium dark grey, N-4, medium grey N-5, and N-3 dark grey. Thinly laminated shale with thin silty stringers. Shale 95% (N-3 25%, N-4 50% N-5 = 20%) Silt 5%.
2891'9"	2894'4"	2'7"	Shale N-4 medium dark grey with thin laminations of N-3 dark grey shale. Very small silty stringers N-7 very light grey, calcareous and small specs of carbonaceous materials. 80% N-4, 15% N-3, 5 % N-7.
2894'4"	2901'8"	7'4"	Shale N-3 dark grey with silty stringers 5 GY 6/1 greenish grey from 1/16" to 1/2" thick non-calcareous several carbonaceous fossils @ 2900' 85% N-3, 15% 5 GY 6/1.
2901'8"	2908'9"	7'1"	Shale 5 GY 4/1 dark greenish grey laminated with N-3 dark grey stringers 2905 changes to 5 Y 2/1 olive black. Section from 2902 to 2905 highly fractured horizontally. Also few silty stringers 5 GY 8/1 light greenish grey. Non-calcareous 45% 5 Y 2/1, 35% 5 GY 4/1, 15% N-3 .5% 5 GY 8/1.
2908'9"	2917'	8'3"	Shale N-4 medium dark grey laminated with N-3 dark grey and silty stringers 5 GY 6/1 greenish grey. (Slightly calcareous) highly fractured and diskings. Carbonaceous materials app. 2916' 35% N-4, 35% N-3, 30% 5 GY 6/1.
2917'	2924'	7'	Shale, 5 GY 2/1 greenish black laminated with 5 GY 4/1 dark greenish grey shale. Few silty stringers 5 GY 8/1 light greenish grey (slightly calcareous) carbonaceous materials scattered throughout 60% 5GY 2/1 35% 5 GY 4/1, 5% 5 GY 8/1.
2924'	2932'	8'	Shale, medium dark grey N-4 and N-3 dark grey and some N-5 medium grey. Silty stringers are found throughout (non-calcareous). Some small worm burrows. Loading effects are evident. Shale → 95% (N-3, 10%; N-4, 60%; N-5 25%) and silt = 5%.

LINCOLN COUNTY, W. VA. #20403

Top	Bottom	Thickness (ft.)	Lithologic Description
2932'	2939'	7'	Shale, medium dark grey N-4. Thin laminations of N-4 and N-3 dark grey with some layers of N-5 also present. Carbonaceous material is evident 2 mm. Some loading features evident. There is some amount of greenish grey shale 5 GY 6/1. Shale 95% (N-3 = 20%, N-4 = 50%, N-5 = 20%, 5 GY 6/1 = 5%) Silt = 5-10%.
2939'	2947'	8'	Shale, N-4 medium dark grey. Some laminations of N-3 and N-5 along with greenish-grey 5 GY 6/1 shale. Silty stringers are intermittently found. Carbonaceous fossils (~ 2mm) are evident and silty calcareous stringers are found throughout. A .2' silty zone is found (with cross-bedding) ~ 2940'. Shale 90% (N-3, 15%; N-4 50%, and N-5 15%, greenish grey 5 GY 6/1 10%) Silt: 10%.
2947'	2953'	6'	Shale, N-4 medium dark grey. Thin layers of N-3, dark grey, N-5 medium grey and 5 GY 6/1 greenish grey are prevalent. Thin stringers (<2 mm) are evident throughout section. Shale: 98% (N-3, 20%; N-4, 45%; N-5, 20%; 5 GY 6/1, 12%) and silt 2-5%.
2952'	2958'8"	6'8"	Shale, medium dark grey N-4 with thin laminations of N-3, dark grey and N-5 medium grey layered throughout this core section. Silty calcareous sections of thin stringers found at 2958.0, 2954.5, and 2953.0. Globules of pyrite 5 mm ~ 2956.5'. Shale: 90% (N-3 15%, N-4 50%, N-5, 25%) silt - 10%.
2958'8"	2965'	6'4"	Shale, medium dark grey, N-4, alternating .05'-.1' zones of N-4 and N-5 zones with some greenish grey 5 GY 6/1 also. Calcareous silty 1" zones are scattered throughout. Some pyrite nodules .05' are found throughout also. Shale 85% (N-3 10%; N-4 50%, N-5 15%; and 5 GY 6/1 10%) silt 15%.

LINCOLN COUNTY, W. VA. #20403

Top	Bottom	Thickness (ft.)	Lithologic Description
2965'	2972'	7'	Shale, N-2 greyish black thinly laminated with N-4 medium dark grey silty stringers 5 GY 6/1 1/16" to 1" calcareous N-4 zones slightly silty. Loading and cross-bedding in silty stringers. Flecks of carbonaceous material throughout 40% N-2, 40% N-4, 20% 5 GY 6/1.
2972'	2978'11"	6'11"	Shale, 5 Y 2/1 olive black thinly laminated with N-5 medium grey shale. Intermittent silt stringers (calcareous) N-6 medium light grey 75% 5 Y 2/1, 20% N-5, 5% N-6.
2978'1"	2986'4"	8'3"	Shale, N-3 dark grey. Section is very uniform. Carbonaceous plant material is found at several places. Thin silty calcareous stringers at 2982.5' and 2985.0' shale 98% (N-4) and silt, 2-5%.
2986'4"	2992'8"	6'4"	Shale, N-4 medium dark grey. Core section is fairly uniform with thin alternating layers of N-3, N-4, N-5 and 5 GY 6/1 greenish grey. Silty zones (thin stringers) calcareous at 2988.0 and 2991.5. N-4 shale is darker, almost N-3, dark grey. Shale 90% (N-3 - 15% N-4 50% N-5, 15%, 5 GY 6/1, 10%) silt, 10%.
2992'8"	2999'6"	6'10"	Shale, 5 Y 2/1 olive black thinly laminated with 5 GY 6/1 greenish grey shale. Silty stringers 1/16" 3/16" calcareous 5 GY 8/1. Carbonaceous fragments 2993', 94, + 95' pyrite nodules 2997'2". 90% 5 Y 2/1, 5% 5 GY 6/1, 5% 5 GY 8/1.
2999'6"	3008'	8'6"	Shale N-2 greyish black laminated with 5 GY 4/1 dark greenish grey. Little flecks of carbonaceous material throughout. 1 large carbonaceous fragment at 3001' 75% N-2, 25% 5 GY 4/1.

LINCOLN COUNTY, W. VA. #20403

Top	Bottom	Thickness (ft.)	Lithologic Description
3008'	3010'	2'	Shale N-3 dark grey thinly laminated with N-2 greyish black. 85% N-3 15% N-2.
3010'	3017'10"	7'10"	Shale, N-4 medium dark grey. The core is fairly uniform (3010-3013) with some N-3 and N-5. From 3013-3017 there are silty calcareous stringers and silty cross-bedded zones throughout with N-4 and N-3. Shale 75% (N-3, 15% N-4, 40%; N-5 and 5 GY 6/1 10%) silty zones and stringers, 25% N-7.
3017'10"	3024'6"	6'8"	Shale, N-4 medium dark grey, with layers of N-3, N-5 and some greenish grey 5 GY 6/1. Silty zones of 1-2" are found throughout, with most of them calcareous (2" ~ 3010.2 and 3024.0) silt is ~ N-7, light grey. Some small <2mm carbonaceous material throughout. Shale 90% (N-3, 10%, N-4 50%, N-5, 20% greenish grey 10%) silt, N-7 10%.
3024'6"	3032'6"	8'	Shale, N-4 medium dark grey, with some N-3 and N-5 laminations. Silty zones (calcareous) with cross-bedding at 3024.0 and 3029.5. Silty stringers are found throughout. Some greenish-grey are evident also. Shale 90% (N-3).
3032'6"	3039'10"	7'3"	Shale, N-4 medium dark grey. Greenish-grey 5 GY 6/1 and N-3 dark grey are laminated throughout. Mineralized vertical fractures (dolomite) between 3036-3039. Silty stringers are scattered. Shale 85% (N-4, 40%; N-5, 20% greenish-grey 10% N-3, 15%) silt 15% N-7.
3039'10"	3047'2"	7'4"	Shale N-3 dark grey laminated with 5 Y 2/1 olive black silty stringers and worm borrows 5 GY 6/1 greenish grey. Vertical fracture mineralized (dolomite) 3039'-3042' 2 @ 2046'. 55 % N-3, 40% 5 Y 2/1, 5% 5 GY 6/1.
3047'2"	3053'8"	6'6"	Shale N-3 dark grey laminated with N-2 and silty stringers 5 GY 6/1 greenish grey (calcareous) One main vertical mineralized fracture, at times 3 or 4 smaller vertical fractures. 85% N-3, 12% N-2, 3% 5 GY 6/1.

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Top	Bottom	Thickness (ft.)	Lithologic Description
3053'8"	3061'	7'4"	Shale, N-4 medium dark grey, with zones and laminations of N-3, N-5, silt, and some greenish grey. Two mineralized vertical fractures (calcareous). Calcareous silty zones at 3054; 3058; and 3059' (loading features). Shale 80% N-3, 10%; N-4, 40%; N-5 20% 5 GY 6/1 10%) silt, 10%.
3061'	3066'10"	5'10"	Shale, N-3 dark grey laminated with zones of 5 YR 2/1 brownish black. Couple silty stringers at 3061 and 3063'6". One mineralized vertical fracture. 85% N-3, 15% 5 YR 2/1.
3066'10"	3069'1"	2'3"	Shale, N-3 dark grey. Some zones of N-4 medium dark grey with several zones of calcareous silty laminations. Two parallel mineral filled vertical fractures are prominent. Shale 90% (N-3 45%, N-4 40% and N-5 5%) Silt, 10%.
3069'	3073'10"	4'10"	Shale, N-4 medium dark grey, with alternating zones of N-3 and N-5 shale. Mineral filled vertical fracture (calcareous), calcite and dolomite. Some greenish grey 5 GY 6/1 zones ~.1'. Shale 95% (N-3 = 20%, N-4, 55%; N-5, 10%; 5 GY 6/1, 10%) silt 5%.
3073'10"	3078'10"	5'	Shale, N-4 medium dark grey, core section is fairly uniform. Some small zones of greenish-grey and thin layers of N-3. Mineral filled fracture (vertical and slightly calcareous). Shale 95% (N-3 15%; N-4 50% N-5 and 5 GY 6/1, 25%) silt 5%.
3078'10"	3087'	8'2"	Shale, N-4 medium dark grey, core section from 3078-3084 is fairly consistent is laminations of N-4, N-3, N-5, and greenish-grey (5 GY 6/1). The rest of core is consistent in N-4 shale with thin stringers. Shale 98% (N-3 15%, N-4 60% N-5 and 5 GY 6/1 25%) silt, 2-3%.

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Top	Bottom	Thickness (ft.)	Lithologic Description
3087'	3092'7"	5'7"	Shale, N-4 medium dark grey, zones of N-4 with N-5 medium grey, N-3 dark grey, and greenish grey 5 GY 6/1. Silty calcareous zones are evident around 3088'. These show evidence of worm burrowing. The section from 3089'-3092'7" is fairly uniform in N-4. Shale = 95% (N-3 10%, N-4 50%, N-5 and 5 GY 6/1 = 35%) silt = 5%.
3092'7"	3098'	5'5"	Shale, N-4 medium dark grey with zones of N-2 greyish black 1 silty zone 3094'6" calcareous 5 GY 6/1 greenish grey 65% N-4, 32% N-2, 3% 5 GY 6/1.
3098'	3104'4"	6'4"	Shale, N-3 dark grey with zones of 5 Y 2/1 olive black and silty stringers 5 GY 6/1 (calcareous) cross-bedding in silty zone @ 3103' 45% N-3, 45% 5 Y 2/1, 10% 5 GY 6/1.
3104'4"	3111'	6'7"	Shale, 5 GY 4/1 dark greenish grey laminated with 5 Y 2/1 olive black 1 silty stringer @ 3106'8" 5 GY 6/1 calcareous. Disking 60% 5 Y 2/1, 38% 5 GY 4/1, 2% 5 GY 6/1.
3111'	3117'	6'	Shale, 5 GY 4/1 dark greenish grey thinly laminated with 5 Y 2/1 olive black and silty stringers 5 GY 6/1 greenish grey (calcareous cross-bedded) 45% 5 GY 4/1, 50% 5 Y 2/1, 5% 5 GY 6/1.
3117'	3123'	6'	Shale, N-4 medium dark grey with alternating zones (1"-2") of N-3, N-4, N-5 and 5 GY 6/1. A silty calcareous zone is at 3121.5' with cross-bedding. Some carbonaceous material throughout. Shale 95% (N-3 15% N-4 55% N-5 10% 5 GY 6/1 15%) silt, 5%.
3123'	3128'5"	5'5"	Shale, N-4 medium dark grey, core section is fairly uniform with N-4 from 3123-3125. From 3125-3128 there are alternating zones N-3, N-4 and N-5 with grey-green also. Shale 98% (N-3 15%; N-4 60%; N-5 10% greenish grey 5 GY 6/1 13 %) silt 2-3%.

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Top	Bottom	Thickness (ft.)	Lithologic Description
3126'	3132'8"	6'8"	Shale, N-4 medium dark grey with some 1-2" zones of N-3, N-4, N-5 and 5 GY 6/1. Silty calcareous 1" zones at 3127, and 3130.5. Shale 95% (N-3 15%; N-4 60%; N-5 and 5 GY 6/1 20%) silt N-7, 5%.
3123'8"	3139'4"	6'8"	Shale, greenish grey 5 GY 6/1, with zones (1-2") of N-3, N-4, and N-5. Silty (calcareous) zones at 3133, 3134, and 3137'. Cross-bedding and thin layers of shale are noted in silt zones. Shale 90% (N-3, 10%; N-4, 30%; N-5, 15% 5 GY 6/1, 35%) silt N-7, 10%.
3139'4"	3147'6"	8'2"	Shale, medium dark grey N-4, with alternating 2-3" zones of greenish-grey 5 GY 6/1 found throughout. Siltstone zone found around (non-calcareous) 3140'. Some N-3 stringers shale 95% (N-4, 40%; 5 GY 6/1 40% N-3 15%) silt 5%.
3147'6"	3154'	6'6"	Shale, greenish grey 5 GY 6/1, with 1-2" zones of N-3 dark grey along with N-4 medium dark grey. Silty calcareous zones at 3152' and 3153'. Some loading effects is evident in silty zones. Shale (5 GY 6/1, 50%; N-4, 30%; N-3, 102; N-5, 5%) Silt N-7 5%.
3154'	3162'	8'	Shale, 5 GY 4/1 dark greenish grey intermittently bedded with N-2 greyish black and silty stringers 5 GY 6/1 greenish grey non-calcareous and cross-bedded 55% 5 GY 4/1, 40% N-2, 5% 5 GY 6/1.
3162'	3169'	7'	Shale, N-4 medium dark grey thinly laminated with N-2 greyish black and silt stringers 5 GY 6/1 greenish grey (silt calcareous and cross-bedded) N-4 60%, N-2 35%, 5 GY 6/1 5%.
3169'	3176'7"	7'7"	Shale, 5 GY 4/1 dark greenish grey laminated with N-2 greyish black and silt zones and stringers 5 GY 6/1 greenish grey (calcareous and cross-bedded) large zone N-2 3173'-3174'8". 65% N-2 30% 5 GY 4/1, 5% 5 GY 6/1.

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Top	Bottom	Thickness (ft.)	Lithologic Description
3176'7"	3182'6"	5'11"	Shale, N-2 greyish black with intermittent zones of silty shale 5 GY 4/1 dark greenish grey. Zone from 3178'4" to 10" is very calcareous 75% N-2, 25% 5 GY 4/1.
3182'6"	3185'5"	2'11"	Shale, N-2 greyish black with few laminations of 5 GY 4/1 dark greenish grey. Spore casts pyritized 95% N-2 5% 5 GY 4/1.
3185'5"	3191'5"	6'	Shale, N-4 medium dark grey, with zones of greenish-grey 5 GY 6/1. Some N-3 zones 1-2" with silty thin stringers (calcareous). Shale N-4 50% N-3 10% greenish-grey 5 GY 6/1 30% N-5 5%) silt 5%.
3191'	3198'6"	7'6"	Shale, N-4 medium dark grey, with thin laminations of N-3, N-4 and greenish-grey 5 GY 6/1, and some N-5. A 3" silty zone at 3191.4' calcareous with thin stringers of N-4. Shale (N-3, 15%; N-4 40%; N-5, 10%; greenish-grey, 20%) Silt 5%.
3198'6"	3206'7"	8'1"	Shale, N-4 medium dark grey, with alternating zones of N-3 (~1"), greenish-grey 5 GY 6/1, and N-4, 5. Silt calcareous zones (2-3") at 2302 and 2303.5. Cross-bedding is evident also in the silt. Thin stringers of silt is evident throughout the core section. Shale 90% (N-3, 15%; N-4, 40%; N-5, 10%; 5 GY 6/1, 20%) silt, 10%.
3206'7"	3212'	6'5"	Shale, medium dark grey N-4, with zones of N-3, and N-4 along with greenish-grey 5 GY 6/1 shale. Silt zones at 3206.5' and 3309.2'. Thin laminations of silt are found throughout the core. Shale 90% (N-3 15% N-4 40% N-5 15%; 5 GY 6/1 = 20%) silt 10%.
3213'	3219'8"	6'8"	Shale, N-2 greyish black with intermittent zones of 5 GY 4/1 dark greenish grey, slightly silty, and non-calcareous. 2" zone @ 3219'6" 5 Y 6/1 light olive grey non-calcareous fine silt. 50% N-2, 48% 5 GY 4/1 2% 5 Y 6/1.

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Top	Bottom	Thickness (ft.)	Lithologic Description
3219'8"	3228'	8'4"	Shale, 5 Y 2/1 olive black thinly laminated with 5 GY 4/1 dark greenish grey slightly silty shale. Silt zone 2" @ 3221'6" non-calcareous and cross-bedded. Carbonaceous material @ 3223'8" 50% 5 Y 2/1 48% 5 GY 4/1 2% 5 GY 6/1.
3228'	3234'8"	6'8"	Shale, 5 GY 4/1 dark greenish grey laminated with 5 Y 2/1 olive black shale. Few small silty stringers 5 Y 6/1 light olive grey slightly calcareous with loading features 65%, 5 GY 4/1, 34% 5 Y 2/1, 1% 5 Y 6/1.
3234'8"	3242'8"	8'	Shale, 5 GY 4/1 dark greenish grey laminated with N-2 greyish black with silt zones 5 GY 6/1 light greenish grey (calcareous loading features) 55% 5 GY 4/1, 35% N-2, 10% 5 GY 6/1.
3242'8"	3248'11"	6'11"	Shale, greenish-grey, 5 GY 6/1, with thin zones (1-2") of N-3, dark grey, N-4 medium dark grey, and silty N-7 stringers. Silty, non-calcareous zones at 3247.5' and 3248.8'. Cross-bedding is evident. Shale 85% (N-3, 10%; N-4, 40%; N-5; 10%; and greenish-grey 5 GY 6/1 25%) silt, 15%.
3248'11"	3256'11"	8'	Shale, greenish-grey 5 GY 6/1, with thin and large layers of N-3 and N-4 shale. Thin silty non-calcareous stringers are found also. Shale 95% (greenish-grey, 60%; N-3 20%; N-4, 15%) silt, 5%.
3256'11"	3263'7"	6'8"	Shale, 5 GY 4/1 dark greenish grey intermittent bedding of N-3 dark grey. Silty stringers 5 Y 6/1 light olive grey with worm burrows and cross-bedding non-calcareous. 60% 5 GY 4/1, 35% N-3, 5% 5 Y 6/1.
3263'7"	3271'4"	7'9"	Shale, 5 GY 6/1, green-grey, with N-3 zones (1-2") and zones of N-5, 5 GY 4/1. Some small calcareous stringers are intermittently found throughout. Shale 95% (N-3, 15%; N-4, 20%; N-5, 10%, 5 GY 6/1, 30%; 5 GY 4/1, 20%), silt, 5%.

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Top	Bottom	Thickness (ft.)	Lithologic Description
3271'4"	3278'	6'8"	Shale, 5 GY 4/1 dark greenish grey thinly laminated with N-2 grey black shales. 70% 5 GY 4/1, 30% N-2.
3278'	3286'2"	8'2"	Shale, 5 GY 4/1 dark greenish-grey thin laminations of N-2 greyish black shale. Silty zone @ 3284'4" 5 Y 6/1 light olive grey calcareous 70% 5 GY 4/1, 28% N-2, 2% 5 Y 6/1.
3286'2"	3293'6"	7'4"	Shale, greenish-grey 5 GY 6/1 with 5 GY 4/1 dark greenish grey with thin N-3 zones and stringers found throughout the core section. Shale 96% (5 GY 6/1 35%; 5 GY 4/1, 35%; N-2,3 30%) silt, 4-5%.
3293'6"	3300'6"	7'	Shale, greenish-grey 5 GY 6/1 and 5 Y 6/1 light olive grey. Thin zones of N-3 and N-4 are intermittently found throughout. A 3" silty calcareous zone is found at 3294.7'. Shale 95% (N-3, 20%; N-4, 15%; 5Y 6/1 and 5 GY 6/1, 60%;) silt, 5%.
3300'6"	3306'	6'6"	Shale, 5 GY 4/1 dark greenish grey with intermittent zones of N-2 greyish black shales. Disking 6-10/ft. 60% 5 GY 4/1 40% N-2.
3306'	3312'10"	6'10"	Shale, 5 GY 4/1 dark greenish grey with zones of 5 YR 2/1 brownish black small silty stringers 5 GY 8/1 light greenish grey (calcareous) 65% 5 GY 4/1, 34% 5 YR 2/1, 1 % 5 GY 8/1.
3312'10"	3319'5"	6'7"	Shale, 5 GY 4/1 dark greenish grey with zone of 5 YR 2/1 brownish black. Worm burrows filled with calcareous silty material. 5 Y 6/1 light olive grey. 70% 5 GY 4/1 29% 5 YR 2/1, 1% 5 Y 6/1.
3319'5"	3327'4"	7'11"	Shale, 5 GY 4/1 dark greenish grey. with zones of 5 YR 2/1 brownish black. 65% 5 GY 4/1 35% 5 YR 2/1.

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Top	Bottom	Thickness (ft.)	Lithologic Description
3327'4"	3334'8"	7'4"	Shale, N-4 medium dark grey, with greenish-grey 5 GY 6/1 and 5 GY 4/1 dark greenish-grey. Bands of N-3 are evident throughout along with calcareous silty zones (2-3") with some cross-bedding. Shale 90% (N-3 15%; N-4 75%; greenish-grey 30%; dark green, 20%) silt, 10%.
3334'8"	3342'5"	7'9"	Shale, greenish-grey 5 GY 6/1 with intermittent laminations and zones of N-3 ($\frac{1}{2}$ -2"), N-5, 5 G 4/1, and silty calcareous stringers. Loading effects are seen in this section. Shale, 85% (N-3, 15%; N-5, 10%; 5 GY 6/1, 30%; 5 GY 4/1, 30%:) silt, 15%.
3342'5"	3349'2"	7'9"	Shale, greenish grey 5 GY 6/1 and light olive grey 5 Y 6/1. Alternating zones of N-3 and N-2 with greenish-grey shales. Thin stringers of calcareous silt are found throughout. Shale 85% (N-2, 3, 15%; N-4 25%; 5 GY 6/1 30%; 5 Y 6/1 30%) silt, 15%.
3349'2"	3356'8"	7'6"	Shale, N-4 medium dark grey, with alternating zones of N-2, N-3, N-4, 5 GY 6/1 and 5 G y/1 shale calcareous silt zones (1-2") and stringers are also found throughout. Shale 85: (N-2, 3, 15%) N-4, 15%; 5 GY 6/1, 30%; 5 G 6/1 75%) silt, N-7 15%.
3356'8"	3358'3"	1'7"	Shale, 5 GY 4/1 dark greenish-grey and 5 GY 2/1 greenish black 5-5% 5 GY 4/1, 45% 5 GY 2/1.
3358'3"	3364'	5'9"	Shale, N-2 greyish black with thin zones of 5 GY 4/1 dark greenish grey. Pyrite filled spores throughout. 85% N-2, 15% 5 GY 4/1.
3364'	3372'5"	8'5"	Shale, 5 Y 2/1 olive black with zones of 5 GY 4/1 dark greenish-grey and silty stringers 5 GY 6/1 light greenish grey calcareous. Worm burrows pyrite filled (calcareous) spore casts also 50% 5 Y 2/1, 48% 5 GY 4/1, 2% 5 GY 6/1.

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Top	Bottom	Thickness (ft.)	Lithologic Description
3372'5"	3379'2"	6'9"	Shale, 5 GY 4/1 dark greenish grey with zones of 5 Y 2/1 olive black and silty stringers and zones 5 GY 6/1 light greenish grey. (calcareous silty zones) cross-bedding worm burrows and loading features evident (calcareous) 60% 5 GY 4/1, 35% 5 Y 2/1, 5% 5 GY 6/1.
3379'2"	3387'1"	7'11"	Shale, 5 GY 4/1 dark greenish grey with zones of 5 Y 2/1 olive black and silty calcareous zone 5 GY 6/1 light greenish grey cross-bedding in silt. 65% 5 GY 4/1, 30% 5 Y 2/1 5% 5 GY 6/1.
3387'1"	3394'	6'11"	Shale, greenish-grey 5 GY 6/1, with 1-2" zones of N-3 intermittently found. N-4 and N-5 layers are also evident. Silty calcareous stringers are found throughout. Shale 95% (N-3 20%; N-4 15%; N-5 10%; greenish-grey 5 GY 6/1 55%) silt, 5%.
3394'	3402'2"	8'2"	Shale, N-4 medium dark grey, with zones and laminations of N-3, 5 GY 6/1, and N-4 found intermittently. Zones of N-2 are found also with a large zone at 3401.5' Shale 95% (N-2 20%; N-3, 10%, N-4, 30%; greenish-grey, 5 GY 6/1; 25%) silt, 5%.
3402'2"	3409'2"	7'	Shale, N-2 with some N-3 core section is fairly uniform with some pyrite and silt. Shale, N-2 and N-3, 98%; and silt 2-3%.
3409'2"	3416'10"	7'8"	Shale, N-2 greyish black and N-3 dark grey. Most of the core section has N-2 greyish black with pyrite lenses. N-3 zones occur near 3409-11 (4-5"). Shale 99% (N-2 80%; N-3 18%) and silt pyrite 1-2%.
3416'10"	3422'2"	5'4"	Shale, N-4 medium dark grey, with thin laminations of silt (non-calcareous) and some pyrite stringers. Core section is fairly uniform with N-4. Shale 98% (N-4) silt and pyrite 2-3%.

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Top	Bottom	Thickness (ft.)	Lithologic Description
3422'2"	3478'	5'10"	Shale, medium dark grey N-4 and 5 GY 6/1 with zones of N-3, N-5, N-4 and silty non-calcareous stringers. Some pyrite is found also. Shale 90% (N-3 10%; N-4 40%; N-5 10%; 5 GY 6/1 30%) silt, 10%.
3428'6"	3434'5"	5'11"	Shale, medium dark grey N-4 with N-3 dark grey zones also. Some zones (1-2") of greenish-grey 5 GY 6/1 and dark greenish grey 5 GY 4/1. Some very thin stringers and laminations of silt. Shale 98% (N-3 15%; N-4 40%; N-5 5%; 5 GY 6/1 20%; 5 GY 4/1 15%) silt 2% pyrite 1%.
3434'5"	3441'	6'7"	Shale, medium dark grey N-4, with N-3 dark grey and N-2 greyish black. 5 GY 4/1 zones are also present. Very little silt is present. Shale 98%, (N-2 15%; N-3 20%; N-4 35%, 5 GY 6/1 15%, 5 GY 4/1 15%) silt, 2%.
3441'	3448'	7'	Shale N-3 dark grey with zones of N-4 medium dark grey very small silty stringers. Pyrite nodules. 75% N-3, 25% N-4.
3448'	3454'	6'	Shale, 5 GY 4/1 dark greenish grey with zones of N-2 greyish black and silty zones of 5 GY 8/1 light greenish grey. Silty zones calcareous with pyrite filled worm burrows. Large carbonaceous material @ 3448'1". 70% 5 GY 4/1, 25% N-2, 5% 5 GY 8/1.
3454'	3461'8"	7'8"	Shale, N-4 medium dark grey with greenish-grey 5 GY 6/1 zones, N-3 zones (1-2") and calcareous silty stringers throughout. Pyrite nodules, loading effects and possible worm burrows are evident. Shale (N-2 10% N-3 10%; N-4 40%; 5 GY 6/1 25%) silt N-7 15%.
3461'8"	3467'9"	6'1"	Shale, N-3 dark grey with intermittent zones of 5 GY 4/1 dark greenish grey and some silty stringers 5 GY 6/1 (calcareous) Pyrite nodules present 85% N-3, 14% 5 GY 6/1, 1% 5 GY 6/1.

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Top	Bottom	Thickness (ft.)	Lithologic Description
3467'9"	3475'	7'3"	Shale, 5 GY 4/1 dark greenish grey with zones of N-3 dark grey and N-4 medium dark grey and silty zones 5 GY 6/1 greenish grey (calcareous) and cross-bedded) 50% 5 GY 4/1, 20% N-3, 20% N-4, 10% 5 GY 6/1.
3474'	3481'1"	7'1"	Shale, 5 Y 2/1 olive black to N-2 greyish black with zones of 5 GY 4/1 dark greenish grey. Greenish grey zones slightly calcareous with few loading features. 40% 5 Y 2/1, 40% N-2, 20% 5 GY 4/1.
3481'1"	3487'6"	6'5"	Shale, 5 GY 6/1 greenish grey to 5 GY 4/1 dark greenish with few zones of N-3 dark grey and silty stringers (5 GY 6/1 calcareous, cross-bedded) worm burrows (calcareous) throughout. 45% 5 GY 6/1, 45% 5 GY 4/1, 10% N-3.
3487'6"	3493'8"	6'2:	Shale, and siltstone N-3 dark grey shale with silty shale 5 GY 6/1 slightly calcareous zones. and N-7 light grey silt zones also calcareous. Worm burrows and cross-bedding throughout-outstanding loading feature with slickenside of 3493'. 45% N-3, 40% 5 GY 6/1, 25% N-7.
3493'8"	3501'4"	7'8"	Shale, dark grey N-3, with calcareous large 1.5' siltstone at 3493'8". Alternating zones of N-5 medium grey are found throughout with loading features. Pyrite nodules are evident in the N-3 sections. Shale 65% (N-3 40% N-4 15% N-5 10%) silt 35%.
3501'4"	3508'3"	6'11"	Shale, dark grey N-3 with very thin silty stringers found in the zone. Some N-5 shale near 3507 with a 6" zone of N-3 shale also. N-5 shale is silty and calcareous. Shale 90% (N-3 60%, N-4 10%; N-5 20%) silt 10%.

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Top	Bottom	Thickness (ft.)	Lithologic Description
3508'3"	3514'8"	6'5"	Shale, N-4 medium dark grey, with zones of silty calcareous shale from 3508-3511. Loading features are found in this section. N-3 shale is found from 3511-3514'8" with thin stringer of silty N-5 shale. Shale 80% (N-3 30%; N-4 35%; N-5 15%) silt 20%.
3514'8"	3522'2"	7'6"	Shale, N-3 dark grey, with some areas darker N-2 while there are some bands (1-4") with 5 GY 6/1 greenish grey (loading effects are evident). Shale 95% (N-3 dark grey 55%; N-4 20%; N-5 5%; 5 GY 6/1 20%) silt N-6 5 %.
3522'2"	3529'2"	7'	Shale, dark grey N-3 with some N-4 medium dark grey. Core is fairly uniform. Pyrite stringers are found throughout. Shale 98% (N-3 60% N-4 75% 5 GY 6/1 5%) silt 5% Pyrite 5%. Gas odor present on fresh surface.
3532'	3538'8"	6'8"	Shale, N-5 medium grey with intermittent zones of N-2 greyish black from 1/2" to 4" thick and small calcareous silty stringers 5 GY 8/1 light greenish grey. 75% N-5, 20% N-2, 5% 5 GY 8/1.
3538'8"	3547'	8'4"	Shale, N-2 greyish black from 3540-47. Odor of gas is evident on fresh surface. There are alternating zones (1-3") of greenish grey 5 GY 6/1, 5 GY 4/1, N-4 and N-3 from 3538-3540'. There are calcareous silty stringers near 3539'. Shale 99% (N-2 70%; N-3 10% 5 GY 6/1, 5 GY 4/1 25%; N04 and N-5 2-4%) silt 1-2%.
3547'	3553'9"	6'9"	Shale, N-2 greyish black from 3547'-3550' 5 GY 6/1 and 5 GY 4/1 with silty non-calcareous zones. From 3550-3553, smell of gas on fresh surface is evident. Shale 98% (N-2 70%, N-3 10% 5 GY 6/1, 5 GY 4/1 15% N-5 2-3%) silt 2-3%.

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Top	Bottom	Thickness (ft.)	Lithologic Description
3553'9"	3561'7"	7'10"	Shale, N-2 greyish black interbedded with 5 GY 6/1 greenish grey slightly calcareous silty shale. Few silty stringers 5 GY 8/1 light greenish grey very calcareous worm burrows some filled with pyrite, some cross-bedding 75% N-2, 22% 5 GY 6/1, 3 % 5 GY 8/1.
3561'7"	3568'4"	6'9"	Shale, N-2 greyish black with the core section being fairly uniform. A 4" 5 GY 6/1 zone at 3568' is evident with some loading at the level below this. Some pyrite is found in N-2 shale. Shale 99% (N-2 90% N-3 4% 5 GY 6/1 5%) Silt 1-2%. Smell of gas present.
3568'4"	3574'4"	6'	Shale, N-2 greyish black with zones of 5 GY 6/1 greenish grey slightly calcareous shale. Cross-bedding, loading and worm burrows evident in lighter zones 90% N-2 10% 5 GY 6/1.
3574'4"	3581'6"	6'2"	Shale, N-2 greyish black with zones of 5 GY 6/1 greenish grey and slightly calcareous loading and worm burrows small pyrite nodules in zones at 3577.3' 90% N-2 10% 5 GY 6/1.
3582'6"	3588'	5'6"	Shale, N-2 greyish black with zones of 5 GY 4/1 and 5 GY 6/1 greenish grey ~ 3583. Loading is evident at contacts between N-2 and 5 GY 6/1. Pyrite is evident in the N-2 greyish black sections. Shale 85% N-2, 5-10% 5 GY 6/1 5% 5 GY 4/1.
3588'	3593'	5'	Shale, N-2 greyish black, with thin layers of 5 GY 6/1 greenish grey found at 3591.5'. Thin laminations of 5 GY 6/1 are also evident and some loading features are present. Some pyrite is evident in N-2. Carbonaceous fossils present. Shale N-2 90%, 5 GY 6/1 10%.

LINCOLN COUNTY, W. VA. #20403

Top	Bottom	Thickness (ft.)	Lithologic Description
3590'	3597'6"	7'6"	Shale, N-1 black with some N-2 and N-3 also. There are some zones and thin stringers of 5 GY 6/1 and 5 GY 4/1, greenish grey. Pyrite is found mostly in the N-1 and N-2 shale. Shale 98% N-1 and N-2, 85%; N-3 5% 5 GY 6/1 and 5 GY 4/1 5-10%, silt <2%.
3597'6"	3603'4"	5'10"	Shale, N-2 greyish black with some N-1 and N-3. There is a zone of 5 GY 6/1 greenish grey 8" at 3597'6". Pyrite is found abundantly throughout the N-2 shale. Shale N-2 80%; N-1, 3 10% 5 GY 6/1 10%.
3603'4"	3610'	6'6"	Shale, N-3 medium dark grey with zones of N-2, N-3, and 5 GY 6/1 and 5 GY 4/1. Thin laminations of silt and N-5 shale are also found. Shale 95% (N-2 20%; N-3 25%; N-4 15%; 5 GY 6/1 20% 5 GY 4/1 10%) silt 5%.
3610'	3617'6"	7'6"	Shale, N-3 medium dark grey, with large zones of N-2 and 5 GY 6/1. Thin laminations of N-2, N-3, N-4 and 5 GY 6/1 are evident at 3612 and 3614. A thin calcareous silty zone 1/4" at 3616'. Shale 95% (N-2 35%; N-3 20%; N-4 10%; 5 GY 6/1 30%) silt 5%.
3617'5"	3623'8"	6'3"	Shale, N-2 greyish black with zones of 5 GY 4/1 dark greenish grey at 3617.5' small calcareous band at 3617.9 and the 5 GY 4/1 is slightly calcareous carbonaceous material 3620' with barite replacement and carbonaceous fossil fragment pyritic nodules throughout loading features and worm burrows? 95% N-2 5% 5 GY 4/1.
3623'8"	3631'	7'4"	Shale, N-2 greyish black with a 6" zone of slightly calcareous silty shale 5 GY 6/1 greenish grey and siltstone @ 3628' pyritic nodules and replacement forms carbonaceous zone 3624.1 with barite vein filling carbonaceous material 3726.7' 90% N-2, 10% 5 GY 6/1.

LINCOLN COUNTY, W. VA. #20403

Top	Bottom	Thickness (ft.)	Lithologic Description
3631'	3637'6"	6'6"	Shale, N-2 greyish black with thin laminations of 5 GY 4/1 dark greenish grey slightly calcareous silty shales. *Possible beginnings of mineralized fracture @ 3634.6' calcareous material. Large pyrite nodule at 3632.2' smaller ones throughout pyrite filled worm burrows. 90% N-2, 10% 5 GY 4/1.
3637'6"	3643'7"	6'1"	Shale, N-3 dark grey with zones of 5 GY 4/1 dark greenish grey slightly calcareous silty shale and smaller stringers 1/8" to 1/4" 5 GY 6/1 greenish grey silty shale. Pyrite nodules throughout 90% N-3, 9% 5 GY 4/1, 1% 5 GY 6/1.
3643'7"	3649'	5'5"	Shale, N-3 dark grey with large zones of 5 GY 4/1 calcareous silty shale laminated with N-4 medium dark grey shales 1/8" pyrite band at 3647'1" pyrite nodules and worm burrows present calcareous replacement at 3647'2" 30% N-3, 70% 5 GY 4/1.
3648'	3654'3"	6'3"	Shale, greenish grey 5 GY 6/1 with a N-2 zone (1') at 3678. Thin laminations of N-3, N-4 and 5 GY 6/1. Some 5 GY 4/1 is also present. Most of greenish-grey zones are very calcareous. Shale 85% (N-2 15% N-3 20% N-4 5% 5 GY 6/1 25% 5 GY 4/1 20%) silt 5%.
3654'3"	3661'7"	7'4"	Shale, N-5 and 5 GY 6/1, medium greenish grey. Thin laminations of N-3, N-4, N-5, 5 GY 6/1 are evident throughout the core section. Shale is very calcareous and some silt is evident. Shale 90% (N-3 15%; N-4 15%; N-5 15% N-6 15%; 5 GY 6/1 40%) silt, 5%.
3661'7"	3668'2"	6'7"	Shale, 5 GY 6/1 greenish-grey with thin laminations of N-3, N-4 and 5 GY 4/1. Green shale is slightly calcareous. Shale 90% (5 GY 6/1, green grey, 40%; 5 GY 4/1 15%, N-3 15% N-4 70%) silt 10%.

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Top	Bottom	Thickness (ft.)	Lithologic Description
3668'2"	3674'3"	6'1"	Shale, green grey 5 GY 6/1 with thin stringers and laminations of N-3, N-4, 5 GY 6/1 and 5 GY 4/1. Shale (green-grey) is slightly calcareous. Shale 90% (5 GY 6/1 40%; 5 GY 4/1 15%; N-3, 20%; N-4 15%) silt 10%.
3674'3"	3681'7"	7'4"	Shale, 5 GY 6/1 green grey with thin laminations and stringers of N-2, N-3, N-4, 5 GY 6/1 and 5 GY 4/1. The green grey zones are very calcareous. Shale 85% (N-2 10%; N-3 15%; N-4 15%; 5 GY 6/1 25%; 5 GY 4/1 25%) silt, 15%.
3681'7"	3688'3"	6'8"	Silty shale 5 GY 4/1 dark greenish grey (slightly calcareous) with zones of N-3 shale from 1/16" to 2". Many loading features, pyrite nodules, and worm burrows present. Fossils @ 3684' 85% 5 GY 4/1, 15% N-3.
3688'3"	3694'7"	6'4"	Silty shale, 5 GY 4/1 dark greenish grey (calcareous) with laminations of N-4 and N-3 medium and dark grey. Loading features, worm burrows, and pyrite nodules evident throughout. 75% 5 GY 4/1, 10% N-4, 15% N-3.
3694'7"	3702'6"	7'11"	Silty shale 5 GY 4/1 dark greenish grey calcareous with thin laminations of N-4 medium dark grey shale couple small zones of 5 Y 6/1 light olive grey also calcareous. Loading, worm burrows, and pyrite nodules evident. 80% 5 GY 4/1, 17% N-4, 3% 5 Y 6/1.
3702'6"	3708'6"	6'	Silty shale, 5 GY 4/1 dark greenish grey calcareous thin laminations of N-4 medium dark grey shale, loading worm burrows carbonaceous material with barite vein filling 3704.2' and 3708.0' pyrite nodules evident 75% 5 GY 4/1, 25% N-4.
3706'	3711'11"	5'11"	Shale, 5 GY 6/1 and N-5 with a zone (2') of 5 GY 4/1 at 3706-3708'. Thin laminations are found of N-3, N-4, N-5, 5 GY 6/1 and 5 GY 4/1. Light green grey shale is calcareous. Shale 90% (N-3 15%; N-4, 15%; N-5 15%; 5 GY 6/1 30%; 5 GY 4/1 15%) silt 10%.

LINCOLN COUNTY, W. VA. #20403

Top	Bottom	Thickness (ft.)	Lithologic Description
3711'11"	3718'	6'1"	Shale, 5 GY 6/1 green-grey with thin laminations of N-2, N-3, N-4, and 5 GY 6/1. Some zones of 5 GY 4/1 also exist. Shale is calcareous and some iron-stained silty stringers exist around 3713'. Shale 90% (N-2 10%, N-3 10%; N-4 20%; N-5 10%; 5 GY 6/1 30%; 5 GY 4/1 10%) silt 10%.
3718'	3724'2"	6'2"	Shale, 5 GY 4/1 with thin layers and laminations of N-3, N-4, N-5, 5 GY 6/1, and 5 GY 4/1. Silt zones and silty stringers are scattered throughout and are very calcareous. Shale 95% (N-2, 10%; N-3 20%; N-4 20%; 5 GY 6/1 20% 5 GY 4/1 25%) silt 5%.
3724'2"	3731'11"	7'9"	Silty shale, 5 GY 4/1 dark greenish grey (slightly calcareous) laminated with N-2 shales greyish black and siltstone zones 5 GY 6/1 greenish grey (very calcareous) Loading features worm burrows (some pyritized) and pyrite nodules. 60% 5 GY 4/1 35%; N-2, 5% 5 GY 6/1.
3731'11"	3738'8"	6'9"	Silty shale, 5 GY 4/1 dark greenish grey (slightly calcareous) with laminations of N-3 shale and 6" zone of 5 GY 6/1 greenish grey siltstone (very calcareous). Loading feature and worm burrows (some pyritized). 75% 5 GY 4/1, 20% N-3, 5% 5 GY 6/1.
3738'8"	3745'	6'4"	Silty shale, 5 GY 4/1 dark greenish grey calcareous with zones of N-3 shale dark grey worm burrows very calcareous pyritized worm burrows pyritic nodules carbonaceous shell fossil 3738'8" plant fossile fragment 3744'6" 80% 5 GY 4/1 20% N-3.
3745'	3746'	1'	Same as above.
3746'	3752'7"	6'7"	Shale, N-4 medium dark grey, core section is fairly uniform. Some shades of N-5 is evident. Some portions are slightly calcareous. Shale: 100% N-4. Small slickenside evident at 3750'.

LINCOLN COUNTY, W. VA. #20403

Top	Bottom	Thickness (ft.)	Lithologic Description
3752'7"	3759'5"	6'10"	Shale, N-4 medium dark grey with zones of 5GY4/1 dark greenish grey (slightly calcareous). Loading, slickensides, and worm burrows, present 60% N-4 40% 5GY4/1.
3759'5"	3767'2"	7'7"	Shale, N-4 medium dark grey with zones of 5GY4/1 slightly calcareous silty shale. Slickensides present on sheer fractures some loading features present, 50% N-4, 50% 5GY4/1.
3767'2"	3773'4"	6'2"	Silty shale, 5GY4/1 dark greenish grey calcareous thinly laminated with N-4 medium dark grey to N-3 dark grey shale. Loading features and worm burrows present. 85% 5GY4/1, 10% N-3, and 5% N-4.
3773'4"	3781'	7'8"	Silty shale, 5GY4/1 dark greenish grey thinly laminated with N-4 medium dark grey shales and 5GY8/1 light greenish grey (very calcareous) siltstone. Few worm burrows and loading features. 90% 5 GY4/1, 8% N-4, 2% 5GY8/1.
3781'	3787'7"	6'7"	Shale, green grey (5GY6/1) with thin laminations of dark grey shale (N-3) interbedded throughout the section. Green grey shale is slightly calcareous. The overall percentages of the shale are these: medium dark grey (N-3) = ~ 35% and the green grey shale is ~ 65%.
3787'7"	3793'10"	6'3"	Shale, green grey (5GY6/1) is dominant shade of the shale. Loading effect is due to compaction features in certain interfaces of the different shades of shale. Thin laminations of medium dark grey shale are evident in most of the core interval. The percentages of shades of shale are these: medium dark grey shale (N-3) = 15%, medium grey shale (N-4) = 10%, green grey shale (5GY6/1) = 75%
3793'	3801'	8'0"	Shale, thin laminations of N-3 interbedded in large zones of greenish grey (5GY6/1) calcareous green-grey, 70% greenish grey 30% dark grey.

LINCOLN COUNTY, W. VA. #204Q3

Top	Bottom	Thickness (ft.)	Lithologic Description
3801'6:	3807'6"	6'	Shale large zones N-4 medium dark grey 1' zone on bottom N-3 dark grey (5GY6/1) calcareous greenish grey silty shale. 65% medium grey 35% dark grey.
3808'	3814'	6'	Shale, thinly laminations of N-5 medium grey interbedded in large zones of N-4 medium dark grey slightly calcareous 85% medium grey 15 dark grey.
3814'	3820'	6'	Shale, thin laminations of N-3 dark grey in zones of greenish grey (5GY6/1) calcareous 75% N-5 30 % N-3.
3820'4"	3826'4"	6'	Grey green shale 3820-21 green grey 3821-23'6" thin laminations N-3 and N-5 non-calcareous 25% N-3, 45% greenish grey 5GY6/1, 30% medium light green N-6.
3826'9"	3833'	6'3"	Shale thin laminations N-4 N-5 3828'2" silty stringer 3828'10" silty stringer 5GY6/1 calcareous and silty thin laminations and loading 3831'8" N-3-N-5 70% greenish grey, 20% medium light grey, 10% medium grey.
3833'	3839'10"	6'10"	Shale, greenish grey 5GY6/1 calcareous with thin laminations of dark grey, shale and silty stringers pyrite filled worm burrow 3838' 65% greenish grey 35% dark grey.
3839'10"	3847'7"	7'9"	Shale greyish black N-2 and Greenish grey 5GY6/1 calcareous zone interbedded. Worm burrows throughout--some burrows with pyrite outside "shell" with quartzite fill. 80% greenish grey, 20% greyish black.
3847'7"	3853'4"	5'9"	Shale, medium grey (N-5), medium dark grey (N-4) and N-3) dark grey. Silty stringers are found throughout. Worm burrows (cross-sections).05' are filled with pyrite ring silt and quartz, non-calcareous. N-2 (greyish black) starts at 3852.9'. N-5 (15%) N-4 (50%) N-3 (20%)(N-2) = 15%.

LINCOLN COUNTY, W. VA. #20403

Top	Bottom	Thickness (ft.)	Lithologic Description
3853'4"	3859'6"	6'2"	Shale, medium grey (N-5) and medium dark grey (N-4). Thin laminations are found in this area with loading features. Silty zones are evident in this section. A 10" zone of N-2 shale is seen at 3858' N-5 is calcareous. N-5 (40%) N-4,3) → (40%), N-2 (20%).
3859'6"	3866'9"	7'3"	Shale, green-grey 5GY6/1 and 5GY4/1 with thin silty iron stained stringers (calcareous). Some zones of N-2 (6") at 3859.8 and 3864.0. Some loading features in N-2. 5GY6/1 = 30% 5G4/1 = 30% N-4 (20%) N-2 (20%).
3866'9"	3873'4"	6'7"	Shale, green-grey 5GY6/1 and N-2 thin laminations and 2-3" zones. Loading features are evident throughout. Worm burrows are evident. 5GY6/1 (green-grey) → 55%, N-2 (30%), N-3 → (15%).
3873'4"	3880'	6'8"	Shale, fairly consistent dark greenish-grey 5GY4/1 with a few silty stringers (calcareous) and a 4" zone of dark grey N-3 on bottom mineral filled fracture app. 3874 (calcareous) 95% greenish grey 5GY4/1 5% dark grey N-3.
3880'	3887'3"	7'3"	Shale, dark greenish-grey 5GY4/1 thinly laminated few small shale stringers 1 zone 5" grey black N-2 few worm burrows stringer and worm burrows slightly calcareous 95% 5GY4/1 5% N-2.
3887'	3893'5"	6'5"	Shale, thinly laminated of greenish grey and dark greenish grey 5GY4/1 growing progressively darker toward bottom. grey black N-2 few worm burrows and spore casts fill with pyrite small silty stringers (calcareous) 80% 5GY6/1 20% N-2.
3893'5"	3898'10"	5'5"	Shale, dark greenish grey 5GY4/1 thin lamination of medium dark grey N-4 one 6" zone dark grey N-3 calcareous several worm burrows pyrite filled. 3894'8" carbonaceous material in fracture 50% 5GY4/1 35% N-4, 15% N-3.

LINCOLN COUNTY, W. VA. #20403

Top	Bottom	Thickness (ft.)	Lithologic Description
3898'	3903'7"	5'7"	Shale greenish-grey 5GY6/1 thin laminations of medium grey N-5 slightly silty shale (calcareous) couple zones grey black N-2 numerous. worm burrows pyrite filled few pyrite filled worm shaped forms 2 large worm burrows at 3899'8" and 9" filled with silt 80% 5GY6/1, 10% N-5, 10% N-2.
3903'7"	3910'	6'3"	Shale, greenish grey 5GY6/1 with thin laminations of medium dark grey N-4 slightly calcareous and silty 4" zone greyish black N-2 with pyrite nodules or worm burrows with calcareous metallic looking material in the middle @ 3907' 2 natural sheer fractures with slickenside 3908' 90% 5GY6/1, 5% N-4, 5% N-2.
3910'	3917'10"	7'10"	Shale dark greenish grey 5GY4/1 thinly laminated with medium dark grey N-4 numerous silty stringers 1/8" to 1/2" thick, whole sample calcareous. 3912'4" large worm burrow fill with coarse silty material very calcareous.
3917'10"	3924'4"	6'6"	Shale, dark grey N-3 laminated with medium dark grey N-4 and silty stringers very light grey N-8 loading feature 3920' 3922½'. Several nature fracture with slickenside greyish black N-2 zone 2" with small worm burrows 3923'8" whole sample calcareous 75% N-3 15% N-4, 5% N-9, 5% N-2.
3924'4"	3931'10"	7'6"	Shale, greenish-grey 5GY6/1 with N-3 thin laminations. Some silt zones (stringers) which are calcareous 5GY6/1 is also calcareous. Some N-2 thin stringers. Loading effects evident slickensides at 3925.0' and 3931.5'. N-3 → (40%) N-2 (10%) 5GY6/1 (50%).
3931'10"	3935'6"	3'8"	Shale, N-2 shale with thin laminations of N-4 and greenish-grey. Calcareous worm burrows are evident near 3932.0. N-2 (20%), N-4 (40%) and greenish-grey 5GY6/1 → (40%).

LINCOLN COUNTY, W. VA. #20403

Top	Bottom	Thickness (ft.)	Lithologic Description
3937'	3944'0"	7'	Shale, N-2 shale with thin laminations of greenish-grey, N-4 and N-5. Thin stringers of silty stringers. N-2 (65%) N-4, 5 (20%) 5GY6/1 (15%).
3944'	3951'5"	7'5"	Shale, N-3 with thin layers of greenish-grey shale. Zones of 6-10" are evident with N-1, and N-2 shale. Pyrite is evident in small nodules. Silty zones are evident (stringers) (calcareous) Some worm burrows are present N-3 (45%) N-1, 2 → (30%) 5GY6/1 = 25%.
3951'6"	3957'10"	6'4"	Shale, N-2 with couple small zone of silty olive grey (5Y4/1). Pyrite nodules and pyrite filled worm burrows non-calcareous 98% N-2, 2% 5Y4/1.
3957'10"	3963'8"	5'10"	Shale, N-3 with laminations of 5GY4/1 calcareous silty stringers pyrite filled worm burrows and loading features 70% N-3, 30% 5GY4/1.
3963'8"	3969'9"	6'1"	Shale, fractured all to pieces N-3 and 5GY4/1 some silty stringers 1/4" less pyrite filled worm burrows and nodules 75% N-3, 25% 5GY4/1.
3969'9"	3975'	5'3"	Shale, greyish black N-2 thinly laminated with greenish grey 5GY6/1 (silty slightly calcareous) iron stained silt stringer at 3971'8" spore casts present and carbonaceous material 95% N-2 5% 5GY 6/1.
3975'	3982'4"	7'4"	Shale, dark grey N-3--N-4 medium grey toward bottom with silty stringers (greenish grey 5GY6/1) N-4 zone slightly calcareous spore casts replaced by pyrite bits and fragments of carbonaceous material throughout 60% N-3, 38% N-4, 2% 5GY 6/1.
3982'4"	3988'8"	6'4"	Shale, N-2 and N-4 in large zones 3982-87 fractured badly non-calcareous with few pyrite fill worm burrows and nodules 70% N-4, 30% N-2.

LINCOLN COUNTY, W. VA. #20403

Top	Bottom	Thickness (ft.)	Lithologic Description
3988'	3993'2"	5'2"	Shale, N-3 and N-4 zones non-calcareous N-4 zones more silty mineralized fractures at 3988 app. 2- $\frac{1}{2}$ " length few pyritic nodules and carbonaceous fragments toward lower section 80% N-3 20% N-4.
3993'2"	3999'4"	6'2"	Shale N-4 and N-3 shale with silty stringers and small worm burrows. Some N-2 zones app. 3998'. A large silty zone (3') ~ 3997.0 calcareous N-4 → 40% N-5 10% N-3 → 30% N-2 → 20%.
3999'4"	4006'8"	7'4"	Shale N-3 with thin laminations of green grey shale small stringers of calcareous siltstone. Small pyrite nodules 4005. N-3 60% 5GY6/1 25% N-4 15%.
4006'8"	4013'0"	6'4"	Shale, greenish-grey (5GY6/1) laminations in dark grey (N-3). Calcareous greenish-grey stringers with some silt. Section grades into (N-2) grey-black shale. N-2 (20%), (5GY6/1) 25%, N-2 (55%). Mineral filled fracture at 4009.0'.
4013'	4018'8"	5'8"	Shale, N-3 and N-2, lithology is fairly consistent and uniform pyrite is evident. Dark grey (20%) and grey black (N-2) 80%.
4018'8"	4024'6"	5'10"	Shale, greyish black (N-2). Lithology is fairly uniform in section. Shear fractures are evident in entire section. Pyrite nodules present. Greyish black is 100.%. Section is not broken up--well preserved.
4024'6"	4028'	3'4"	Shale, dark grey → grey black (N-2). Lithology is fairly uniform throughout. Two planes of fractures. Strong smell of kerogen. Pyrite globules are evident. greyish black ~ 100%.

APPENDIX B

LINCOLN COUNTY, W. VA.

CORED WELL #20402

Top	Bottom	Thickness (ft.)	Lithologic Description
2654'	2658'	4	Shale, dark grey N-3 with siltstone stringer greenish grey 5Y 8/1. Cross-bedded in silty zones and some loading effects. Silty zones slightly calcareous N-3 60%, 5GH 6/1 35%, 5% 5Y 8/1
2658.0'	2664.9'	6.9	Siltstone, greenish grey 5GY 6/1, with interbedded shale, dark grey, N-3, loading features toward top of interval, non-calcareous, cross-bedded, 60% 5GY 6/1, 15% 5 GY 4/1, 25% N-3.
2664.9'	2671.83'	6.93	Silty shale, greenish grey 5GY 6/1 and dark greenish grey 5GY 4/1 with interbedded shale dark grey N-3 and greyish black N-2, cross-bedding throughout interval with some loading features also evident, slightly micaceous, non-calcareous, 75% 5GY 6/1, 10% 5GY 4/1, 10% N-3, 5% N-2.
2671.83'	2697.0'	5.17	Silty shale, dark greenish grey 5GY 4/1, with interbedded dark grey N-3 and greyish black N-2, non-calcareous, cross-bedded and loading features, pyritic stringer at 2675.95', 60% 5GY 4/1, 20% N-3, 20% N-2.
2677.0'	2681.92'	4.92	Shale, silty, greenish black, 5GY 2/1 with silt bands dark greenish grey 5G 4/1, extremely cross-bedded throughout the interval, slightly micaceous, 3" calcareous silty zone 2679.35', and 2" calcareous silty zone 2680.6', minor thin silty stringers throughout, 60% 5G 4/1, 40% 5 GY 2/1.
2681.92'	2687'	5.08	Shale, dark grey N-3, with silty dark greenish grey 5GY 4/1, loading features and cross-bedding, pyritic stringer and pyritic nodules, calcareous zone with fossilized worm burrows located 2685.5' to 2685.7', two 1.5" siltstone zone located at 2684' to 2684.5', 65% N-3, 35% 5GY 4/1.

LINCOLN COUNTY, W. VA. #20402

Top	Bottom	Thickness (ft.)	Lithologic Description
2687.0'	2691.5'	4.5	Silty shale, greenish grey, 5GY 6/1 with dark greenish grey bands 5GY 4/1, and interbedded dark grey shale bands N-2 and N-3, micaceous, some slightly calcareous sections, intermittent cross-bedding and loading features present throughout. 5GY 6/1 40%, GY 4/1 40%, N-2 and N-3 20%.
2691.5'	2696.1'	4.6	Siltstone, greenish grey 5GY 6/1, and shale, dark greenish grey, 5GY 4/1, with a few greyish black shale bands, N-2, non-calcareous, slightly micaceous, abundant cross-bedding, 5GY 6/1 70%, 5GY 4/1 25%, N-2, 5%.
2696.1'	2701.0'	4.9	Silty shale, greenish grey, 5GY 6/1, with interbedded dark grey, N-3 and greyish black, N-2 shale bands. Non-calcareous, some worm burrows, slightly micaceous, cross-bedding throughout, 5GY 6/1 - 70%, N-3 - 15%, N-2 - 10%.
2701.0'	2706.5'	5.5	Interbedded stringers of siltstone, light olive grey, 5Y 6/1, thinly laminated with silty shale, dark greenish grey, 5G 4/1, and shale, greyish black, N-2. Non-calcareous, some loading features, cross-bedding present, slightly micaceous. 5Y 6/1 - 5%, 5G 4/1 - 70%, N-2 - 25%.
2706.5'	2710.5'	4.0	Shale, greyish black N-2 and dark grey N-3 with interbedded silty zones, dark greenish grey 5GY 4/1, non-calcareous, with loading features and cross bedding evident, carbonaceous fragment 2606.7', micaceous, spore casts, pyritized spore casts and pyritic nodule, pyritized worm burrow 2707.5' 35% N-3, 35% N-2, 30% 5GY 4/1.

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Top	Bottom	Thickness (ft.)	Lithologic Description
2710.5'	2714.67'	4.17	Shale, medium dark grey N-4 to dark grey N-3 with interbedded silty zones, dark greenish grey 5GY 4/1, slightly calcareous in silty zones, micaceous, minor loading and cross bedding, 45% N-3, 35% N-4, 20% 5GY 4/1.
2714.33'	2719.42'	5.09	Shale, dark grey N-3 to medium dark grey N-4, interbedded with silty zones dark greenish grey 5GY 4/1, non-calcareous, some cross-bedding and loading, some pyritic traces, micaceous N-3 45%, N-4 30%, 5GY 4/1 25%.
2719.42'	2724.3'	4.88	Shale, medium dark grey N-4 to dark grey N-3, with interbedded silty zones of greenish grey 5GY 6/1, calcareous silty zone at 2722.7', loading features and minor amounts of cross-bedding throughout interval, micaceous, carbonaceous fossil fragment at 2719.5', pyritized spore casts and spores 2720.0', pyritic stringers, 40% N-3, 20% N-4, 40% 5GY 6/1.
2724.3'	2729.7'	5.4	Shale, greyish black N-2 to dark grey N-3 with interbedded silty zones, greenish grey 5G 6/1. Slightly calcareous, some good loading features, slightly micaceous, cross-bedding present throughout. N-2 20%, N-3 35%, 5G 6/6 45%.
2729.7'	2734.4'	4.7	Siltstone, light olive grey, 5Y 6/1 with thin laminations of silty shale, dark greenish grey, 5G 4/1 and interbedded shale, dark grey, N-3 and greyish black N-2. Slightly calcareous micaceous, some loading features and cross-bedding, fracture traces present. 5Y 6/1 25%, 5G 4/1 50%, N-3 15%, N-2 10%.
2734.4'	2739.1'	4.7	Siltstone, greenish grey, 5GY 6/1, interbedded with shale, greyish black, N-2 and dark grey, N-3. Non-calcareous, slightly micaceous, some loading features, abundant cross-bedding. Some poor fracture traces in lower foot of section. 5GY 6/1 55%, N-2 15%, N-3 30%.

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Top	Bottom	Thickness (ft.)	Lithologic Description
2739.1'	2744.4'	5.3	Interbedded silt, light olive grey 5Y 6/1 and greenish grey 5GY 6/1, and shale dark grey N-3 and greyish black N-2. Slightly calcareous in some silty bands, slightly micaceous, some loading features and cross-bedding. 5Y 6/1 10%, 5GY 6/1 25%, N-3 60%, N-2 5%.
2744.4'	2749.5'	5.1	Interbedded silt, light olive grey 5Y 6/1 and greenish grey 5GY 6/1 and shale dark grey N-3 and greyish black N-2. Non-calcareous slightly micaceous, loading features and cross-bedding present. 5Y 6/1 20%, 5GY 6/1 25%, N-3 45%, N-2 10%.
2749.5'	2754.67'	5.17	Shale, dark grey N-3, with interbedded silty zones, dark greenish grey 5GY 4/1, 3" siltstone stringer slightly calcareous at 2752.9', cross-bedding and loading features, slightly micaceous, carbonaceous plant fossil 2751.9', 65% N-3, 35% 5GY 4/1.
2754.67'	2760.0'	5.33	Shale, medium dark grey N-4 to dark grey N-3, with interbedded silty zones dark greenish grey 5GY 4/1, non-calcareous, micaceous, carbonaceous fragment at 2755.0', pyritized spore cast and spores, replacement pyrite, loading features, 40% N-4, 20% N-3, 40% 5GY 4/1.
2760.00'	2765.6'	5.6	Shale, medium dark grey N-4, with interbedded silty zones dark greenish grey 5GY 4/1, 1.0' calcareous silty zone 2762.0', micaceous, loading features and some cross-bedding 55% N-4, 50% 5GY 4/1.
2765.6'	2770.70'	5.1	Shale, dark grey N-3, interbedded silty zones, dark greenish grey 5GY 4/1, non-calcareous, loading features, carbonaceous fossil fragment 2770.3', slightly micaceous 60% N-3, 40% 5GY 4/1.
2770.7 to 3000.0		29.3	Section not cored.

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Top	Bottom	Thickness (ft.)	Lithologic Description
3000.0'	3004.9'	4.9	Shale, dark grey N-3 with a few interbedded silty zones, olive grey, 5Y 4/1. Non-calcareous slightly micaceous, cross-bedding and loading features are absent. N-3 90%, 5Y 4/1 10%.
3004.9'	3009.8'	4.9	Shale, dark grey N-3, and some greyish black N-2 bands with some interbedded silty zones, light olive grey, 5Y 6/1. Calcareous in the silty zones, slightly micaceous, some loading features and cross-bedding present in the middle 2 feet of the section iron staining present in the 3006 and 3007 footages. N-3 65%, N-2 10%, 5Y 6/1 25%.
3009.8'	3014.3'	4.5	Shale, dark grey N-3, and olive grey 5Y 4/1 with interbedded silty zones light olive grey 5Y 6/1. Calcareous in some of the silty zones, slightly micaceous, excellent loading feature at 3013'2", small calcite-filled fractures between 3012' and 3012'6", some cross-bedding N-3 55%, 5Y 4/1 35%, 5Y 6/1 10%.
3014.3'	3018.7'	4.4	Shale, dark grey N-3 and greyish black N-2, interbedded with silty stringers, light olive grey 5Y 6/1. Calcareous in the silty zones, slightly micaceous, some iron staining in 3018', no loading features or cross-bedding present. N-3 80%, N-2 10%, 5Y 6/1 10%.
3018.7'	3023.25'	4.55	Shale, dark grey N-3, with silty stringers greenish grey 5GY 6/1, calcareous in the silty stringers, micaceous, pyritized spore casts 90% N-3, 10% 5GY 6/1.
3023.25'	3027.75'	4.50	Shale, dark grey N-4, with small amounts of silty stringers dark greenish grey 5GY 4/1, spores, spore casts and pyritized spore casts, slightly micaceous calcareous silty stringer, 97% N-4, 3% 5GY 4/1.

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Top	Bottom	Thickness (ft.)	Lithologic Description
3027.75'	3032.42	4.67	Shale, greyish black N-2, with few silty stringers, dark greenish grey 5GY 4/1, a pyritic nodule 3029.5', non-calcareous, pyritic spores, spore casts, micaceous, micro carbonaceous fragments, silty stringer 3031.15', shale is uniform texture throughout interval, 98% N-2, 2% 5GY 4/1.
3032.41	3037.34	4.92	Shale, greyish black, N-2, with three calcareous silty stringers, greenish grey 5GY 6/1, iron staining associated with the silty stringers, spores, spore casts and pyritized spore casts, shale is uniform throughout the interval 95% N-2, 5% 5GY 6/1.
3037.3'	3042.4'	5.06	Shale, greyish black N-2 and olive grey 5Y 4/1. Non-calcareous slightly micaceous, spore casts in 3042', no loading features or cross-bedding present. N-2 40% 5Y 4/1 60%.
3042.4	3047.0	4.6	Shale, greyish black N-2 and dark grey N-3, siltstone stringers 5Y 4/1, which are calcareous. Pyritized spore casts in 3044, and carbonaceous materials in 3033. Shale is non-calcareous but slightly micaceous. No loading features or cross bedding N-2 30%, N-3 40%, 5Y 4/1 30%.
3047.0'	3052.0'	5.0	Shale, greyish black N-2, dark grey N-3, and medium dark grey N-4 with a few silty stringers light olive grey 5Y 6/1. Calcareous in the silty stringers, slightly micaceous, pyritic spores and casts and pyrite filled worm burrow at 3049', no loading features or cross - bedding present. N-2 20%, N-3 40%, N-4 35%, 5Y 6/1 5%.
3052.0'	3057.9	5.9	Shale, dark grey N-3 and greyish black N-2 with interbedded silty zones light olive grey 5Y 6/1. Calcareous in silty zones, slightly micaceous pyritized spores and spore casts present in the middle of the section, iron stains and loading features present in some silty zones, little cross-bedding. N-3 50%, N-2 40%, 5Y 6/1 10%.

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Top	Bottom	Thickness (ft.)	Lithologic Description
3057.9'	3061.17'	3.77	Shale, greyish black N-2 with some dark grey N-3 laminations and silty stringer greenish grey 5GY 6/1, silty stringer is calcareous, slightly micaceous, pyritized spores and spore casts, 80% N-2, 17% N-3, 3% 5GY 6/1.
3061.17'	3065.85'	4.68	Shale, greyisy black N-2, with calcareous silty zones and stringers, medium light grey N-6, micaceous, spore casts and pyritized spore casts, loading features evident in silty zone, 90% N-2, 10% N-6.
3065.85'	3070.75'	4.9	Shale, greyish black N-2, with few calcareous silty zones, dark grennish grey 5GY 4/1, minor loading features, no cross bedding, slightly micaceous, 95% N-2, 5% 5GY 4/1.
3070.75'	3075.00	4.25	Shale, medium dark grey N-4, with interbedded calcareous silty zone, medium light grey N-6, minor loading in silty zones, spore casts and pyritized spore casts, micaceous, flecks of darker N-2 to N-3 are found throughout the interval, 90% N-4, 10% N-6.
3075.0'	3080.5'	5.5	Shale, medium dark grey N-4, dark grey N-3, greyish black N-2, and brownish grey 5YR 4/1, with a few small silty stringers, light olive grey 5Y 6/1. Non-calcareous, slightly micaceous, few loading features and cross-bedding, some pyritized spores. N-4 30%, N-3 30%, N-2 20%, 5YR 4/1 15%, 5Y 6/1 5%.
3080.5'	3085.5'	5.0	Shale, medium dark grey N-4, dark grey N-3, and greyish black N-2, with few silty stringers light olive grey 5Y 6/1. Non-calcareous, slightly micaceous, no loading or cross-bedding features. N-4 45%, N-3 25%, N-2 25%, 5Y 6/1 5%.

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Top	Bottom	Thickness (ft)	Lithologic Description
3095.5'	3090.0'	4.5	Shale, medium dark grey N-4, dark grey N-3, and greyish black N-2, with a few interbedded silty stringers, light olive grey 5Y 6/1. Calcareous in some of the silty zones, slightly micaceous, some iron staining in a few silty zones, some cross-bedding but no loading features. N-4 20%, N-3 40%, N-2 20%, 5Y 6/1 20%.
309Q.0'	3095.0'	5.0	Shale, greyish black N-2 and dark greenish grey 5GY 4/1 with interbedded silty stringers, light olive grey 5Y 6/1. Non-calcareous, slightly micaceous pyrite and pyritized spores and casts present between 3092' and 3093', some loading features and cross-bedding especially in silty zones. N-2 30%, 5GY 4/1 55%, 5Y 6/1 15%.
3095.00'	3099.66'	4.66	Shale, dark grey N-3 to medium dark grey N-4, a few slightly calcareous silty stringers, medium grey N-5, micaceous, pyritic stringers and pyritic nodules, spore casts and pyritized spore casts some iron staining flakes of N-3 material found, 95% N-3 and N-4, 5% N-5.
3099.66'	3104.25'	4.59	Shale, greyish black N-2 to dark grey N-3, with numerous calcareous silty stringers medium grey N-5, minor loading in silty zones, micaceous, few spore casts, 90% N-2, and N-3, 10% N-5.
3104.25'	3109.9'	5.65	Shale, medium dark grey N-4 to dark grey N-3, with few silty stringers, light olive grey 5Y 6/1, pyritic stringers, non-calcareous, micaceous, micro crystalline pyrite, pyritic nodules, spore casts, pyritized spores, N-3 to N-4 98%, 2% 5Y 6/1.

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Top	Bottom	Thickness (ft.)	Lithologic Description
3109.9'	3115'	5.1	Shale, greyish black N-2 to medium dark grey N-4, a calcareous silty zone, medium light grey N-6 at 3110.85' to 3111.15', loading features in silty zone, flakes of N-2 material throughout interval, fossil traces (worm tubes), slightly micaceous, 95% N-2 to N-4, 5% N-6.
3115.0'	3117.7'	2.7	Shale, greyish black N-2 and olive grey 5Y 4/1. Non-calcareous, slightly micaceous, pyritized spores and casts near 3117', no loading features or cross-bedding present. N-2 35%, 5Y 4/1 65%.
3118'	3290'	182	Section not cored.
3290.0'	3293.0	3.0	Shale, dark grey N-3, greyish black N-2, and olive grey 5Y 4/1 with one or two silty stringers, light olive grey 5Y 6/1. Calcareous in the thin silty stringers, slightly micaceous, no loading features or cross-bedding present. N-3 45%, N-2 10%, 5Y 4/1 40%, 5Y 6/1 5%.
3293.0'	3298.4'	5.4	Shale, greyish black N-2 and olive grey 5Y 4/1, with interbedded silty stringers, light olive grey 5Y 6/1. Calcareous in some of the silty zones, iron staining present in some silty zones, slightly micaceous, pyritized worm burrows at 3295' and 3298', pyritized spores and casts throughout, some loading features and cross-bedding especially in silty zones (N-2 25%, 5Y 4/1 55%, 5Y 6/1 20%.
3298.4'	3304.0'	5.6	Shale, brownish black 5YR 2/1 with one silty stringer, greenish grey 5GY 6/1. Non-calcareous, slightly micaceous, pyritized worm burrow at 3301', spores abundant throughout, iron staining in silty zone, no loading features or cross-bedding present 5YR 2/1 95%, 5GY 6/1 5%.

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Top	Bottom	Thickness (ft.)	Lithologic Description
3304.0'	3311.0'	7.0	Shale, olive black 5Y 2/1 and greyish black N-2, with one silty stringer, greenish grey 5GY 6/1. Non-calcareous, slightly micaceous, two or three pyrite nodules, abundant spores, no loading features or cross-bedding present 5Y 2/1 75%, N-2 20%, 5GY 6/1 5%.
3311.0'	3316.25'	5.25	Shale, banded-greyish black N-2 and dark grey N-3, with calcite fracture filling, pyritized stringers and worm burrows, pyritic nodules, micaceous, pyritized spores, spores, spore casts, 99.9% N-2 N-3.
3316.25'	3322.30'	6.05	Shale, medium dark grey N-4 with greyish black N-2 banding, calcareous silty stringers, medium light grey N-6, iron staining in the silty zone, cross-bedding and some loading in the silty zones, pyritic stringers, slightly micaceous, spore casts, pyritized spores, 65% N-4, 10% N-2, 25% N-6.
3322.30'	3328.00'	5.70	Shale, medium dark grey N-4, with banded dark grey N-3 and extremely calcareous silty zones and stringers, medium light grey N-6, minor loading features evident in silty zones, micaceous, flakes of N-2, pyritized spores and spore casts, 80% N-4, 20% N-6.
3328.00'	3333.85'	5.85	Shale, medium dark grey N-4 with greyish black N-2 banding, and calcareous medium light grey N-6 to light grey N-7 silty stringers, pyritic stringers, pyritic nodules, flakes of N-1, micaceous, fossil traces (worm tubes), carbonaceous fragments 3331.42', 95% N-4 and N-2, 59N-6 and N-7.
3333.85	3340.5'	6.65	Shale, greyish black N-2, dark grey N-3, and olive grey 5Y 4/1, interbedded with silty stringers, light olive grey 5Y 6/1. Calcareous in silty zones, slightly micaceous, pyritized worm burrow at 3338', abundant spores, some cross-bedding and loading features--especially in silty zones. N-2 20%, N-3 15%, 5Y 4/1 45%, 5Y 6/1 20%.

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Top	Bottom	Thickness (ft.)	Lithologic Description
3340.5'	3346.6'	6.1	Shale, olive black 5Y 2/1 dark grey N-3, and slightly calcareous silty stringers 5Y 6/1, slightly micaceous. Worm burrow at 3341.4'. 5Y 2/1 90%, N-3 9% 5Y 6/1 1%.
3346.6'	3351.20'	4.6	Shale, dark grey N-3, carbonaceous fragments, flakes of N-1 black, micaceous, pyritic stringers and nodules, N-3 100%.
3351.20'	3357.35'	6.15	Shale, dark grey N-3, micaceous, pyritic stringers and nodules, zone of medium grey shale N-5, whole interval non-calcareous, carbonaceous fragments, 98% N-3, 2% N-5.
3357.35'	3363.15'	5.80	Shale, greyish black N-2 to medium dark grey N-4 with silty stringers, light olive grey 5Y 6/1, non-calcareous pyritic nodules and stringers and worm burrows, carbonaceous fragment, drusy pyritic material, 65% N-2, 34% N-4, 1% 5Y 6/1.
3363.15'	3369.10'	5.95	Shale, black N-1, and a zone of olive grey 5Y 6/1 shale, non-calcareous, pyritic nodules, 95% N-1, 5% 5Y 4/1.
3369.1'	3375.5'	6.4	Shale, greyish black N-2 with bands of medium dark grey N-4, non-calcareous, carbonaceous fragments 3373.1', 70% N-2, 30% N-4.
3375.50'	3381.85'	6.35	Shale, greyish black N-2, with zones of medium dark grey N-4, non-calcareous pyritic nodules, pyritized spore casts, spore casts, N-2 65%, N-4 35%.
3381.85'	3387.25'	6.4	Shale, olive-black, 5Y 2/1, uniform throughout interval pyrite nodules and pyritized worm burrows, with drusy pyritic stringer at 3387.2' shale is slightly micaceous 5Y 2/1 99%.

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Top	Bottom	Thickness (ft.)	Lithologic Description
3424.50'	3431.15'	6.65	Silty shale, medium light grey N-6 with shales banding, greyish black N-2, and silty stringers light grey N-7, loading features and cross-bedding evident throughout silty zones, slightly calcareous in silty zones, numerous pyritic nodules associated with calcite, pyritized worm burrows, micaceous flakes of N-2 throughout interval, slickensides 3426.5', 90% N-6, 7% N-2, 3% N-7.
3431.15'	3437.0'	5.85	Interbedded shale, greyish black N-2, olive grey 5Y 4/1 and siltstone, light olive grey 5Y 6/1. Calcareous in silty zones, slightly micaceous, carbonaceous fragment at 3436', excellent loading features between 3433' and 3434'. N-2 30%, 5Y 4/1 30%, 5Y 6/1 60%.
3437.0'	3443.5'	6.5	Shale, greyish black N-2 and olive grey 5Y 4/1 with silty stringers light olive grey 5Y 6/1. Non-calcareous, slightly micaceous pyritic nodule at 3438', some loading features and cross-bedding. N-2 40%, 5Y 4/1 45%, 5Y 6/1 15%.
3443.5'	3449.4'	5.9	Interbedded shale, greyish black N-2 and olive grey 5Y 4/1 with siltstone, light olive grey 5Y 6/1. Slightly calcareous in silty zones slightly micaceous, some loading features and cross-bedding. N-2 30%, 5Y 4/1 20%, 5Y 6/1 50%.
3449.4'	3455.9'	6.5	Shale, black N-2 and olive grey 5Y 4/1 with interbedded silty stringers, light olive grey 5Y 6/1. Slightly calcareous in most of the silty zones, slightly micaceous pyrite nodules, loading features throughout. N-2 40%, 5Y 4/1 20%, 5Y 6/1 40%.
3455.10'	3461.55'	5.65	Shale, black N-1 with silty zones medium grey N-5, loading features, non-calcareous pyritic nodules, pyritized worm burrow, pyritic stringers, micaceous, 90% N-1, 10% N-5.

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Top	Bottom	Thickness (ft.)	Lithologic Description
3387.25'	3393.25'	6.0	Shale, greyish black N-2 and olive grey 5Y 4/1, with one silty stringer, light olive grey 5Y 6/1. Non-calcareous, slightly micaceous, drusy pyrite stringer at 3387.2', carbonaceous material at 3388.9' no cross-bedding or loading features. N-2 65%, 5Y 4/1 30%, 5Y 6/1 5%.
3393.25'	3399.3'	6.05	Shale, greyish black N-2 and olive grey 5Y 4/1 with interbedded silty stringers, light olive grey 5Y 6/1. Calcareous in silty zones, slightly micaceous, pyritic nodules and stringers abundant throughout, some loading features--especially in silty zones N-2 40%, 5Y 4/1 50%, 5Y 6/1 10%.
3399.3'	3406.1'	6.8	Shale, greyish black N-2 and olive grey 5Y 4/1 with one or two silty stringers, light olive grey 5Y 6/1. Non-calcareous, slightly micaceous, carbonaceous material and pyritic nodules present throughout, no cross-bedding or loading features. N-2 40%, 5Y 4/1 55%, 5Y 6/1 5%.
3406.1'	3412.25'	6.15	Shale, greyish black N-2 with bands medium dark grey N-4, non-calcareous, micaceous, pyritic nodules, carbonaceous fragment 3410.9', N-2 80%, 20% N-4.
3412.25'	3418.50'	6.25	Shale, greyish black N-2, with irregular bands of medium grey, N-5, loading features evident in the N-5, iron staining, pyritic nodules, micaceous flakes of N-2 present in N-5, carbonaceous fragment. 3417.3', 50% N-2, 50% N-5.
3418.50'	3424.50'	6.0	Shale, greyish black N-2, and silty shale medium grey N-5, pyritic nodules and stringers, pyritized worm burrows, iron staining, calcareous, and micaceous in silty shale zones, 50% N-2, N-5 50%.

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Top	Bottom	Thickness (ft.)	Lithologic Description
3461.55'	3467.25'	4.55	Shale, greyish black N-2, strong gas odor when broken, micaceous pyritic nodules, pyritic stringers, (shale interval 3462.85' to 3464' missing) 100% N-2.
3467.25'	3473.25'	6.00	Shale, greyish black N-2, with bands of medium grey N-5, pyritized worm burrow, non-calcareous, micaceous pyritic stringers, some associated with calcium, pyritic nodules, flakes of N-2 in medium grey zones, N-2 60%, N-5 40%.
3473.25'	3479.42'	6.17	Shale, medium grey N-5 with bands of dark grey N-3, and silty zones light olive grey 5Y 6/1, calcareous in silty zones, micaceous, flakes of N-3 in N-5, iron staining in silty zone, pyritic stringers with calcite, 70% N-5, 20% N-3, 10% 5Y 6/1.
3479.42'	3486.1'	6.68	Shale, black N-1 and olive grey 5Y 4/1. Non-calcareous slightly micaceous, pyritic nodules scattered throughout, no loading or cross-bedding features N-1 70%, 5Y 4/1 30%.
3486.1'	3491.9'	5.8	Shale, black N-1 and olive grey 5Y 4/1. Non-calcareous, slightly micaceous, pyrite nodules present, no loading or cross-bedding features N-1 75%, 5Y 4/1 25%.
3491.9'	3497.6'	5.7	Shale, black N-1 and silty shale, olive grey 5Y 4/1. Slightly calcareous in the silty zones, slightly micaceous, some loading features, pyritic nodules present throughout N-1 50% 5Y 4/1 50%.
3497.6'	3503.7	6.1	Shale, greyish black N-2 with silty stringers, olive grey 5Y 4/1 to greenish grey 5GY 6/1. Slightly calcareous in silty zones, slightly micaceous, pyrite nodules iron staining in some silty zones, some loading features. N-2 80%, 5 Y 4/1 to 5GY 6/1 20%.

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Top	Bottom	Thickness (ft.)	Lithologic Description
3503.7'	3509.15'	5.45	Shale, greyish black N-2, with calcareous silty zones, dark greenish grey 5GY 4/1., loading features evident in silty zones, pyritic stringer and nodules, slightly micaceous, spore casts, 90% N-2, 10% 5GY 4/1.
3509.15'	3515.75'	6.60	Shale, greyish black N-2 with non-calcareous silty zones, olive grey 5Y 4/1, loading features evident in silty zones, pyritic nodules and stringers, micaceous, carbonaceous fragments 3514.25' 95% N-2, 5% 5Y 4/1.
3515.75'	3522.00'	6.25	Shale, greyish black N-2, with silty zones greenish grey 5GY 6/1, loading features evident in silty zones, pyritic stringers, iron staining in silty zones, spores and spore casts pyritized worm burrow N-2 70% 30% 5GY 6/1.
3522.00'	3523.6'	1.6	Shale, greyish black N-2, with shale dark greenish grey 5GY 4/1, a few calcareous silty stringers, spores and spore casts, loading features or tear ups, 50% N-2, 50% 5GY 4/1.
3528.60'	3528.00'	4.40	Missing Interval.
3528.00'	3531.08'	3.08	Shale, greyish black N-2 with silty zone olive-grey 5Y 4/1 (non-calcareous) loading in silty zones, pyritic nodule and stringers, spores and spore casts, carbonaceous fossil fragment, odor of gas in interval 80% N-2, 20% 5Y 4/1.
3531.08'	3537.2'	6.12	Shale, brownish black 5YR 2/1 with thin laminations of olive grey 5Y 4/1. Non-calcareous, slightly micaceous, a few pyritite nodules, some loading features and cross-bedding. 5YR 2/1 90%, 5Y 4/1 10%.
3537.2'	3543.2'	6.0	Shale, greyish black N-2 with silty stringers, olive grey 5Y 4/1. Non-calcareous slightly micaceous, a few small pyrite nodules, N-1 75%, 5Y 4/1 25%.

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Top	Bottom	Thickness (ft.)	Lithologic Description
3543.2	3549.1'	5.9	Shale, black N-1 with a silty zone, olive grey 5Y 4/1. Non-calcareous, slightly micaceous, loading features present in silty zone, pyrite nodules scattered throughout N-1 75%, 5Y 4/1 25%.
3549.1'	3555.5'	6.4	Interbedded siltstone, greenish grey 5GY 6/1, olive grey 5Y 4/1, and shale, greyish black N-2. Calcareous in silty zones, slightly micaceous, loading features and some cross-bedding especially in silty zones, fossil fragments at 3551' and 2654'. 5GY 6/1 20%, 5Y 4/1 30%, N-2 50%.
3555.50'	3561.50'	6.	Shale, greyish black N-2, with banded lighter shale, olive grey 5Y 4/1, loading features evident in lighter shale, pyritic stringers, pyritic nodules and stringers, fossil fragment (sh), carbonaceous fragment @ 3560.90', slightly micaceous, 80% N-2, 20% N-4.
3561.50'	3567.45	5.95	Shale, dark grey N-3 with bands of olive grey shale 5Y 4/1, micaceous, pyritic nodules, spores and spore casts, N-3 75%, 5Y 4/1 25%.
3567.45'	3573.65'	6.20	Shale dark grey N-3, with intermittent banding of greenish grey shale 5GY 6/1, pyritic nodules and stringers, loading features evident, micaceous, carbonaceous fragment @ 3572.3', spores and spore casts, 80% N-3, 20% 5GY 6/1.
3573.65'	3578.65'	5.00	Shale, dark grey N-3, with shale, medium grey N-5, slight calcareous silty zones, olive grey 5Y 4/1, pyritic stringer and nodules, carbonaceous fragment 3576', slightly micaceous, loading features in silty zones, 80% N-3, 15% N-5, 5% 5Y 4/1.

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Top	Bottom	Thickness (ft.)	Lithologic Description
3578.65'	3588.1'	9.45	Shale, greyish black N-2, interbedded with silty zones olive grey 5Y 4/1. Non-calcareous slightly micaceous, loading feature and cross-bedding in some silty zones, pyrite nodules scattered throughout, carbonaceous material and barite-filled fractures at 3583.1'. N-2 *0%, 5Y 4/1 20%.
3588.1'	3886.1'	2.98	Section not cored.
3886.1'	3892.1'	6.0	Shale, greyish black N-2, interbedded with silty zones, olive grey 5Y 4/1. Calcareous in silty zones, slightly micaceous, loading features in silty zones, pyrite nodules scattered throughout. slickensides at 3887.6', spores in 3887'. N-2 75%, 5Y 4/1 25%.
3892.1'	3897.9'	5.8	Shale, greyish black N-2, with interbedded silty zones, olive grey 5Y 4/1. Slightly calcareous in silty zones, slightly micaceous, pyrite nodules in 3892' and 3893', slickensides present throughout no loading or cross-bedding features. N-2 85%, 5Y 4/1 15%.
3897.9'	3903.9'	6.0	Shale, greyish black N-2, with silty stringers, light olive grey 5Y 6/1. Calcareous in some silty stringers, slightly micaceous, pyrite nodules and slickensides abundant especially between 3901' and 3902'. N-2 90%, 5Y 6/1 10%.
3903.9'	3910.5'	6.6	Shale, greyish black N-2, and silty zones olive grey 5Y 4/1. Calcareous in silty zones, slightly micaceous, some slickensides, pyrite nodules and stringers abundant, some loading features especially in pyrite stringers. N-2 40%, 5Y 4/1 60%.
3910.5'	3916.5'	6.0	Shale, greyish black N-2, with silty stringers, olive grey 5Y 4/1. Non-calcareous, slightly micaceous, thin bands of pyrite in 3911'. N-2 90%, 5Y 4/1 10%.

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Top	Bottom	Thickness (ft.)	Lithologic Description
3916.50'	3922.08'	5.58	Shale, greyish black N-2 with zones of shale medium grey N-5, pyritic stringers, nodules, and pyritized worm burrows, slickensides, slightly micaceous, non-calcareous, minor carbonaceous fragments, spores (black) and spore casts, very thin calcareous zones, N-2 60%, N-5 40%.
3922.08'	3928.08'	6.0	Shale, greyish black N-2 with medium dark grey shale N-4, micaceous, non-calcareous, pyritic stringers and nodules, slickensides (45° angle), methane odor on fresh surface, cross-bedding, N-2 80%, N-4 20%.
3928.08'	3934.0'	5.92	Shale, greyish black N-2 and silty shale, olive grey 5Y 4/1, with one silty zone, light olive grey, 5Y 6/1. Slightly calcareous in silty zones, slightly micaceous, pyritic stringers abundant, few loading features. N-2 30%, 5Y 4/1 65%, 5Y 6/1 5%.
3934.0'	3942.0'	8.0	Shale, greyish black N-2 and silty shale, dark grey N-3. Calcareous in many sections, slightly micaceous, slickensides at 3936', mineralized fracture between 3934', and 3935', abundant pyrite stringers, loading features present especially in pyrite, some mineralized slickensides, N-2 25%, N-3 75%.
3942.0'	3944.0'		Missing interval.
3944.00'	3951.0'	7.0	Shale, greyish black N-2, with medium grey shale N-5 pyritic stringers and nodules and pyritized worm burrows, calcareous silty stringers loading features evident in N-5, slickensides 45° in 3950' - 3951', numerous calcareous fossil fragments, calcite mineral coating on slickensides, 90% N-2, 10% N-5.

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Top	Bottom	Thickness (ft.)	Lithologic Description
3951.00'	3956.65'	5.65	Shale, greyish black N-2, calcareous, slickensides 3951' - 3952', micaceous, fossil fragments, pyritic nodules, 100% N-2.
3956.65'	3962.9'	6.25	Shale, greyish black N-2, pyritic nodules, Slickensides 45° angle slightly calcareous, flakes of N-1, strong gas odor, shale is uniform throughout interval, some loading features, 100% N-2.
3962.9'	3968.0'	5.1	Shale, greyish black N-2. Calcareous in sections, slightly micaceous, pyrite nodules and stringers scattered throughout, carbonaceous material near 3968'. N-2 100%.